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THE AMERICAN
JOURNAL OF PSYCHOLOGY

Founded by G. Stanley Hall in 1887

Vol. XXIX APRIL, 1918 No. 2

THE EFFECT OF AUDITORY DISTRACTION UPON THE SENSORY REACTION[1]

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The effect upon reaction-time of intercurrent or 'distracting' stimuli has been variously reported. Most frequently the 'distraction' serves to lengthen the time; but sometimes it decreases it; and occasionally, after a brief initial disturbance, it leaves the time unaffected. No explanation can be found, so far as the published researches go, in the nature of the distractors as simple or complex, of this sense-modality or of that. It is possible, however, that their temporal relations are significant. Most of the distractors, in the experiments that showed an increase of the reaction-time, were irregular and intermittent; all of the distractors, in the experiments that showed a decrease or no change, were regular and continuous. This generalization is obtained by the comparison, not of different experimental series within a single investigation, but of separate investigations: in so far, and apart from the fewness of the investigations themselves, it is subject to doubt. It seemed worth while, nevertheless, to examine the effect upon the simple sensory reaction-time of distractors which vary widely in their temporal aspects. This is the specific object of the present study. We believe also, from a review of the experimental work done under 'distraction,' that many studies of the same special sort must be undertaken before the general question can profitably be discussed.

We employed three distractors: one that was continuous

[1] From the Psychological Laboratory of Cornell University.

throughout the entire period of the experiment, *i. e.*, during the intervals of introspective report and of rest as well as during the reactions proper; another that was intermittent, beginning just before and continuing through the reaction; and another that was continuous for a set of ten reactions, but was interrupted during the periods of introspective report and rest. We shall term them henceforth the 'continuous.' the 'intermittent,' and the 'continuous-intermittent' distractors.

Observers. The observers were Miss A. Luce (L), and Mr. A. M. Palmer (P), advanced students in psychology; Dr. G. J. Rich (R), graduate fellow in psychology; and K. M. Dallenbach (D). L, P and R were unfamiliar with the object of the research and with the method of the reaction experiment; D was familiar with both. R and D served throughout the experiment; P began to observe in Jan., 1917, and withdrew from the University in April; L served only during the preliminary period of training.

Apparatus. Two rooms at opposite ends of the laboratory were used for the experiment. The experimenter, with the Hipp chronoscope and its accessories, was in the one room and the observer, with the stimulating and reacting apparatus, in the other.

The chronoscope was operated from make to break, and was controlled by Wundt's large control-hammer, in turn controlled by the Wundt chronograph. The control-hammer varied, according to the chronographic records, less than one five-hundredth. The average for a series of ten readings was $198 \pm 0.36\ \sigma$. The chronoscope varied, according to the control hammer, less than one one-hundredth. This small variation was obtained by a careful adjustment of the springs and current that operated the magnets. The current was obtained from six dry cells wired in series. The strength of the current was kept constant by the aid of a resistance box and a rheochord. With the magnet springs in a fixed position and the current at 3.5 volts and 62.5 milliamperes, the constancy above stated could be obtained for any series of readings of the fall of the control-hammer.

The observer's room was darkened, in order that he might be free from visual distraction. The stimulus was the noise produced by the Wundt sound-hammer, which was placed directly in front of the observer at a distance of 40 cm. As in Evans' experiments,[2] the hammer was so adjusted that the only sound produced was from the impact of the hammer on the anvil. The ordinary 'telegraph' form of key was employed. The key was fastened to the table at a convenient distance to the right and in front of *O*. The forefinger was laid upon the edge of the button. Since a pressure of 400 gr. was necessary for contact, *O* exerted a slight pressure in order to hold the key down. The reaction was made by snapping the finger from the button.

Two flashes of light from a 2.9 volt electric globe were given before every experiment as the 'ready', 'now' signals. Their intensity was greatly reduced by four layers of black cloth. The globe was placed upon the wall in front of *O*, at a distance of 50 cm., and at the level of his eyes. The first flash, the 'ready' signal, was set to occur 3 sec., and the second, the 'now' signal, 1½ sec. before the occurrence of the stimulus. As timed by the Hipp chronoscope they occurred

[2] Evans, J. E., *Archives of Psychology*, XXV, 1916, No. 37, p. 15.

3265 ± 32.6 σ and 1853 ± 11.8 σ respectively before the stimulus. The first flash lasted 695 ± 4.7 σ and the second, 706.8 ± 2.8 σ. These preparatory signals were automatically operated by the Meumann time sense apparatus and the Ludwig-Baltzar kymograph; the apparatus were in *E*'s room and were controlled from his desk by an electrical switch.

Procedure. The first problem was to familiarize the observers with the apparatus, and to train them in the mode and method of response. Directions for the sensory reaction were read to them at the beginning of every hour throughout the period of training.

The length of this period differed for the different observers. It was continued, except in the case of L, until the m. v. of any series of ten reactions was well below 10% of the average.

Although the reactions were computed in series of ten, every one was timed and separately noted; so that if a movement was made prematurely, or occurred under accidental disturbance, etc., the datum could be omitted and the experiment be repeated. The observer designated the occurrence of such faulty reactions by a push upon a bell-button which was on his desk at the right of the reaction key, and which was connected with an electrical buzzer in the experimenter's room.

After every ten reactions *O* wrote an introspective report, which was used primarily as a check upon his mode of reaction. If it indicated that his response tended to be 'muscular', the instructions were re-read: if it showed that they were sensory, the next series was given without further delay.

In the early part of the practice-period only 50 reactions (5 series) were made in an hour. As the observers became more proficient, more reactions were made; and finally 100 reactions (10 series) were obtained at one sitting. During this preliminary training L gave, in all, 173 series; P, 71 series; R, 74; and D, 46.

In the effort to obtain the required constancy of reaction, L's training, as is shown above, was continued far beyond that of the other observers. To no avail, however: for her deviations were nearly as large at the end as they were at the beginning. We give below the data of 10 consecutive series from the early part of training, and of the 10 series taken on the last day of training.

Series from Early Part of Training			Series from Last Day of Training		
Series number	Av. Reaction-time	m. v.	Series number	Av. Reaction-time	m. v.
21.	327.5	92.10	164.	234.8	48.48
22.	321.1	83.06	165.	257.0	54.40
23.	366.2	34.54	166.	276.4	37.80
24.	252.1	63.20	167.	283.5	41.20
25.	314.5	53.10	168.	312.4	38.86
26.	294.0	40.40	169.	307.0	40.20
27.	287.7	38.08	170.	294.3	47.30
28.	262.6	40.20	171.	299.5	37.40
29.	244.5	94.10	172.	318.0	32.00
30.	302.7	55.80	173.	261.8	55.14
Average	297.29	59.46		284.47	43.27

It was evidently impossible for L, under our instructions, to maintain a constant attitude; and her service in this problem therefore ended with the practice-series.

Distractors. A metronome beating 120 in the minute was used as the 'interrupted-continuous' distractor. It was electrically controlled from the experimenter's desk, so that it could be released and checked before and after every distraction-series.

An electric bell was used as the 'intermittent' distractor. It was automatically controlled by the time-sense apparatus. Contact was made after the "Ready, Now" signal, about 1 sec. before the stimulus, and lasted for 2.5 sec. As timed by the Hipp chronoscope, the bell began ringing 1182 ± 10.9 σ before the sound of the stimulus, and continued for 2584.9 ± 19.8 σ.

An electrically driven tuning-fork of 256 vs. was used as the 'continuous' distractor.

Plan of the Experiment. The 'interrupted-continuous' distractor, the metronome, was first employed. During these experiments the three *O*'s served three times a week; 8 to 12 series, according to the length of time needed for the introspective reports, were obtained at a sitting. In the early part of the work, the experiments were so arranged that 4 normal series were taken with every 10 distraction series; later the number of normal series was reduced to 3. The normals were distributed equally often, in every case, to the first, second, third, fourth, etc., places. The work continued under these conditions until R and D had completed 100 series (1000 reactions) with distraction, and 34 and 33 series respectively of the normal type; and until P had completed 59 series with distraction and 29 normal series.

Next the 'intermittent' distractor, the bell, was used. The observers, R and D, served five times a week. Twelve series of reactions were obtained during every hour; only the first and last of these were control series. At the end of two weeks, when 100 distraction series and 20 control series had been obtained, the third distractor was employed.

With the 'continuous' distractor, the tuning-fork, 14 series were obtained during a single hour. The first 5 were distraction series, the next 4 control series, and the last 5 were again distraction series. The observers served five times a week; so that, at the end of a fortnight, 100 distraction series and 40 control series had been obtained.

TABLE II

Average and Mean Variation of the Reaction-times under Distraction and under Normal Conditions

Mode of Distraction	Observer P			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	192.79	23.73	173.80	20.43
2. Intermittent	.....	.....	.....	.....
3. Continuous	.....	.....	.....	.....

TABLE II—Continued

Mode of Distraction	OBSERVER R			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	254.38	37.20	243.11	35.00
2. Intermittent	273.48	31.07	236.14	23.46
3. Continuous	264.65	22.48	255.78	21.35

TABLE II—Continued

Mode of Distraction	OBSERVER D			
	Distraction series		Control series	
	Av.	m. v	Av.	m. v.
1. Interrupted-continuous	206.12	24.85	201.73	23.59
2. Intermittent	220.27	27.65	203.68	21.14
3. Continuous	219.92	21.62	217.46	20.52

The general averages and the mean variations of the reaction-times, under the three modes of distraction and under control conditions, appear in Table II.

The reactions taken under distraction are longer, and their mean variations are larger, than is the case under normal conditions. This relation is constant for all three observers for all three modes of distraction, though the amount of difference, as is shown below in Tables III and IV, varies with the mode of distraction.

TABLE III

The Difference, the Probable Error of the Difference, and the Probable Correctness of the Difference between the Average Reactions under Distraction and those under Normal Conditions.

Mode of Distraction	OBSERVER R			D		
	Dif.	P. E.	P. C.	Dif.	P. E.	P. C.
1. Interrupted-continuous (metronome)	11.27	1.975	100.00	4.39	1.280	98.97
2. Intermittent (bell)	37.34	1.628	100.00	16.59	1.528	100.00
3 Continuous (tuning-fork)	8.87	1.231	100.00	2.46	1.039	94.55

TABLE IV

Difference in Mean Variation of the Reactions under Distraction and under Normal Conditions

Method of Distraction	Observer	
	R	D
1. Interrupted-continuous (metronome)	2.00	1.26
2. Intermittent (bell)	7.61	6.51
3. Continuous (tuning-fork)	1.13	1.00

Tables III and IV show the differences, for the three modes of distraction, in length of reaction-times and in size of their mean variations. These differences are smallest in the case of 'continuous,' and largest in the case of 'intermittent' distraction: the ratios are approximately 1.0:1.5:5.0. The uniformity of the results leads us to conclude *that the 'inhibiting' effect of a distractor varies with its duration and regularity.*

It might be thought that the inhibitory effect is dependent upon the qualitative as well as upon the temporal differences. But (1) in no investigation so far published does the effectiveness of distractors of even greater qualitative difference vary by so great an amount. And (2) D has found, in an attempt to obtain a graded series of distractors, that qualitative difference within a modality has very little if anything to do with the distractive effect.

Table III shows further the probable errors[3] and probable correctnesses[4] of the differences between the two sets of reaction-times. The probable errors are small, and the probable correctnesses are either of mathematical certainty or approach that limit.

Were we to summarize our results at this point, following the example of certain experimenters in the past, we should be led to conclude that the effect of the distractors is constant, and always in the direction of an increased reaction-time. This conclusion is, however, not borne out by the facts obtained from a fractionation of the data. Tables V, VI, and VII show the detailed results for the three modes of dis-

[3] Computed by the formula: $P.E._{diff.\ A\text{-}B} = \sqrt{(P.E._A)^2 + (P.E._B)^2}$. The probable errors of the averages were obtained by the formula: $P.E._M = \frac{0.8453}{\sqrt{n}}$ m.v. Evans (*op. cit.*, 35) says that he calculated his probable errors by the formula $P.E. = \frac{0.8453\ m.v.}{n}$. We assume that the omission of the radical is a printer's error.

[4] See Boring, E. G., *Amer. Jour. of Psych.*, XXVII, 1916, 315-319; also XXVIII, 1917, 454-459.

TABLE V

Times of Sensory Reaction under 'Interrupted-continuous' Distraction (Metronome sounding only during a series) and under Normal Conditions, and Ratios of these Times

Groups of Reactions	OBSERVER														
	P					R					D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Reaction Time	m. v.	Av. Reaction Time	m. v.		Av. Reaction Time	m. v.	Av. Reaction Time	m. v.		Av. Reaction Time	m. v.	Av. Reaction Time	m. v	
1	170.63	20.4	151.75	14.4	1.124	196.92	22.61	207.65	31.22	0.948	233.33	25.53	207.85	20.62	1.122
2	179.68	24.6	158.55	18.0	1.133	258.68	34.42	245.60	36.08	1.052	240.41	22.00	217.65	15.12	1.104
3	188.70	18.4	160.25	10.3	1.177	259.85	35.96	244.07	38.46	1.064	194.98	17.26	190.27	21.01	1.024
4	194.17	17.9	181.95	19.6	1.067	213.83	30.39	230.66	30.18	0.927	203.41	22.69	195.33	24.74	1.041
5	228.05	29.3	211.60	22.8	1.078	259.60	30.24	262.00	31.05	0.990	212.36	21.67	202.52	24.98	1.048
6	203.48	16.7	177.12	12.3	1.149	242.75	46.99	240.27	35.61	1.011	195.82	21.95	169.12	13.74	1.157
7	194.93	25.7	165.87	17.8	1.175	238.02	32.52	242.15	23.67	0.941	210.57	20.30	205.95	20.44	1.022
8	184.77	16.1	160.95	11.1	1.147	271.57	27.77	250.30	27.18	1.084	209.98	16.42	196.70	10 65	1.067
9	183.77	15.7	157.90	9.7	1.163	277.83	31.93	246.65	26.78	1.126	202.43	17.03	212.15	16.55	0.958
10	193.27	22.1	170.70	16 7	1.132	271.68	32.45	220.85	21.16	1.230	175.71	15.91	190.80	16.54	0.920
11	....	....	....	....	....	242.41	26.69	243.25	19.59	0.996	214.91	20.60	218.95	23.10	0.981
12	....	....	....	....	....	260.64	27.90	243.65	33.07	1.069	201.01	15.47	191.50	9.38	1.049
13	....	....	....	....	....	254.24	23.31	238.80	14.76	1.064	211.01	15.89	211.85	10.46	0.996
14	....	....	....	....	....	255.56	25.26	235.65	24.15	1.084	....	....	....	....	....

traction. The daily averages of the reaction-times for the distraction series and the control series, and the ratios of these averages, are shown opposite the numerals which appear in the first column under the caption "Groups of Reactions."

TABLE VI

Times of Sensory Reaction under 'Intermittent' Distraction (bell ringing just before and during reaction) and under Normal Conditions, and Ratios of these Times.

Groups of Reactions	OBSERVER R					OBSERVER D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Reaction time	m. v.	Av. Reaction time	m. v.		Av. Reaction time	m. v.	Av. Reaction time	m. v.	
1	287.35	31.3	260.95	20.4	1.101	237.94	27.4	207.50	18.8	1.146
2	282.11	28.2	234.25	17.3	1.204	209.59	23.7	196.05	17.2	1.069
3	265.31	31.7	228.35	24.1	1.161	205.61	20.5	201.60	21.4	1.019
4	259.51	27.9	239.40	25.5	1.084	241.25	22.4	210.90	15.1	1.143
5	278.60	29.6	226.35	22.1	1.230	227.96	24.9	195.35	21.7	1.166
6	258.62	30.3	240.70	26.1	1.074	216.67	20.7	218.30	22.7	0.992
7	284.63	40.3	259.40	30.0	1.097	208.83	20.6	201.40	20.1	1.036
8	284.89	26.62	243.55	17.8	1.169	194.03	18.5	177.85	20.1	1.090
9	267.10	26.82	232.20	17.6	1.150	237.63	26.1	223.50	15.9	1.063
10	286.65	28.53	196.55	22.9	1.458	227.11	20.8	204.40	26.0	1.110

TABLE VII

Times of Sensory Reaction under 'Continuous' Distraction (tuning-fork sounding during periods of reaction and of rest) and under Normal Conditions, and Ratios of these Times.

Groups of Reactions	OBSERVER R					OBSERVER D				
	Distraction series		Control series		Ratio	Distraction series		Control series		Ratio
	Av. Reaction time	m.v.	Av. Reaction time	m.v.		Av. Reaction time	m.v.	Av. Reaction time	m.v.	
1	282.44	29.3	254.80	26.7	1.108	230.44	16.9	236.40	18.4	0.974
2	262.04	23.7	270.40	21.5	0.972	217.93	21.3	198.20	21.6	1.099
3	255.61	26.6	257.95	26.0	0.990	215.05	27.0	214.90	21.2	1.000
4	266.20	26.1	265.30	25.8	1.003	202.25	21.0	208.15	16.1	0.971
5	238.48	21.7	245.10	21.0	0.964	207.60	20.7	208.97	20.8	0.993
6	256.60	23.2	240.57	24.3	1.066	225.71	17.6	217.40	18.1	1.038
7	260.55	21.5	210.50	21.5	1.237	217.04	17.3	221.90	18.5	0.978
8	275.83	24.2	287.70	24.8	0.958	222.56	17.0	215.90	14.0	1.030
9	267.02	27.3	258.30	24.2	1.033	233.98	14.3	238.60	13.8	0.980
10	281.31	23.2	267.70	23.1	1.050	226.69	16.1	220.75	17.5	1.026

These tables show that no distractor operates constantly, or always in the same direction. The variability is large, and extends (with but a single exception) both to the positive and

to the negative sides. Table VIII gives the frequency of this alternation for both observers under the three modes of distraction; *i. e.*, shows the number of days on which the average distraction-reaction was greater and less than the average normal reaction.

TABLE VIII

Number of Days on which the Average Distraction-Reaction was Greater and Less than the Average Normal Reaction

Method of Distraction	Observer			
	R		D	
	Greater	Less	Greater	Less
1. Interrupted-continuous (met.)	9	5	9	4
2. Intermittent (bell)	10	0	9	1
3. Continuous (tuning-fork)	6	4	5	5

Though in case 2 R offers an exception to the rule that 'distraction' sometimes facilitates reaction, the variability of the ratios has a wider range for this distractor than for the other two. It extends from 1.074 to 1.458; whereas for the metronome it is 0.927 to 1.230, and for the tuning-fork 0.958 to 1.237.

These results, which corroborate those of Evans,[5] show the

[5] *Op. cit.*, 36-40; 72-80. Evans' six observers all gave instances of facilitation. A's reaction to light, under a light-distraction, was inhibited 20 times and facilitated 19 times (Evans, p. 36, says 18 times; but the table, p. 72, shows 19); under a sound distraction was inhibited 9 times and facilitated once; and under a touch-distraction was inhibited in all 10 times. B's reaction to light, under light-distraction, showed 16 cases of inhibition and 3 of facilitation; under sound-distraction, 4 cases of inhibition and 4 of facilitation; and under touch-distraction, 7 cases of inhibition only. Observers C and D reacted to a sound-stimulus. For C, only 2 of the 37 cases of sound-distraction, and none of the 9 cases of light or the 7 cases of touch-distraction, showed facilitation. D showed facilitation in only 1 out of 17 cases of sound-distraction. (Evans, p. 24, says that the reaction to a sound-stimulus with sound-distraction was followed, in the cases of C and D, by reaction to sound with light-distraction, and then by reactions to light with touch-distraction. The results for D's last two sets of reactions are not quoted; and the table p. 76 that gives C's results for the last set of reactions shows that the stimulus was a sound instead of a light.) The results of observers E and F more nearly parallel our own; for these observers were trained in the method of reaction with a view to elimination of the effect of practice from the distraction-series. E, under sound-distraction, gave 10 cases of inhibition and 1 of facilitation; under light-distraction, 9 cases of inhibition and 5 of facilitation; and under touch-distraction, 5 cases of inhibition and 4 of facilitation. F, with a sound-distractor, gave 9 cases of inhibition and 1 of facilitation; with a light-distractor, 3 cases of inhibition and 4 of facilitation; and with a touch-distractor, 4 cases of inhibition and 3 of facilitation.

fallacy of arguing from averages. The effect of distraction is equivocal; it sometimes increases and sometimes decreases the reaction-time.

Evans regards the reactions that show 'facilitation' as exceptional and atypical cases, due to lack of interest, poor adaptation, overtraining, staleness, confusion, inattention, and chance. He therefore omits them from consideration, and concludes that "the distractions were true distractions," which "affected the reactions by making the time longer."[6] The omission of these data does not, however, follow logically from the explanation offered of them; the explanation suggests rather that the effect of distraction upon reaction is dependent upon the observer's attitude.

That the 'exceptional cases' should not be omitted is shown, indeed, both by the frequency of their occurrence in Evans' and our own results, and also by the fact (Tables V, VI, VII) that their probable errors are as small and their probable correctnesses as large as those of the cases that indicate inhibition. For the sake of brevity, we give the actual figures of only one *O* under one distractor. We choose the instance of D in Table VII, where the distraction of the tuning-fork brought about an equal number of cases of inhibition and facilitation. The differences between the daily averages of the distraction series and the control series, the probable errors, and the probable correctnesses of these differences, are set forth in Table IX.

TABLE IX

Differences between D's Daily Averages under the Distraction of the Tuning-Fork and under Control Conditions, with the Probable Errors and the Probable Correctnesses of these Differences

Groups	Dif.	P. E. Dif.	P. C. Dif.
1	−5.96	2.861	92.07
2	+19.73	3.415	100.00
3	+0.15	3.658	51.07
4	−5.90	2.803	92.17
5	−1.37	3.309	60.89
6	+8.31	2.857	97.47
7	−4.86	2.895	87.14
8	+6.66	2.373	97.09
9	−4.62	2.217	91.97
10	+5.94	2.723	92.92

The one set of figures is plainly as valuable as the other; neither may be neglected. In other words, the data are heterogeneous: a conclusion confirmed by Tables V, VI and VII, which prove that the differences between the two kinds

[6] *Op. cit.*, 40, 53.

of reaction from day to day are greater than the differences for a single day. The daily averages, on the other hand, are homogeneous, as the small variations clearly show.[1]

We cannot take recourse to the effect of practice. That this effect was eliminated is shown implicitly by Tables V, VI and VII, and explicitly by Table X. This table gives the averages and mean variations found in both halves of the experiments for each observer under every mode of distraction. The values appearing under 'Distraction' are the averages and mean variations of 500 reactions; the number of reactions represented in the values under 'Control' varies. With the 'interrupted-continuous' distraction, the value for the first half was obtained from 190 reactions for R and 180 for D; that of the second half from 150 reactions in each case. The values for the other two modes of distraction were derived from 100 and 200 reactions respectively.

TABLE X

Averages and Mean Variations of the Distraction and Normal Reactions for the Halves of the Experiments

Modes of Distraction	Observer							
	R				D			
	Distraction		Control		Distraction		Control	
	1 half	2 half	1 half	2 half	1 half	2 half	1 half	2 half
Inter.-Con. (Metronome)	247.11 ±30.25	261.63 ±26.91	248.23 ±32.63	238.23 ±25.13	210.21 ±20.43	201.55 ±17.18	200.80 ±20.08	202.17 ±15.17
Intermittent (Bell).....	274.37 ±29.76	276.38 ±30.55	237.86 ±23.89	234.48 ±22.90	224.47 ±23.76	216.85 ±21.32	202.28 ±18.85	205.09 ±20.97
Continuous (Tuning-fork)	260.95 ±25.48	268.26 ±23.88	258.71 ±24.20	252.95 ±23.58	214.65 ±23.30	225.19 ±16.46	213.32 ±19.62	222.91 ±16.36

The first halves of the distraction-series are, with all three modes of distraction, shorter for R than the last halves. The relation is so constant, and the differences and the probable correctnesses of the differences are so large, that we have evidence not only that practice was eliminated, but also that there was a change of attitude, from interest to boredom. The control series, it is true, seem at first inspection to show the effect of practice; the second halves are shorter than the first. It is to be remembered, however, that the control series were taken less frequently than the distraction-series. We

[1] The mean variations given in these tables (Tables V, VI, and VII) are not the averages of the mean variations of the ten series, but are the mean variations from the averages of 100 reactions.

may infer, then, that on the introduction of the various modes of distraction, R was interested in the new conditions imposed upon him. After 500 or more reactions under the same conditions, his attitude changed; he reacted less efficiently. At first, while R was interested in the reactions, a change from distraction to control did not greatly affect the reaction: the averages of the first halves of the distraction and control series are very close. As habituation and tedium set in, the change from distraction to control became more and more marked; until the control reactions, in contrast with the monotony of the distraction-reactions, were performed more efficiently.

The results for D are the exact converse of those for R. Where R shows an increase in the average reaction, D shows a decrease, and contrariwise. The explanation given for R's results will not hold for D's, though we find in D's results evidence of the same change, habituation and consequent shift of attitude. This evidence is presented, first, by the control series, the averages of which show a steady increase with the advance of the experiment; and secondly by the large and sudden increment in the averages, under the third mode of distraction, of both the distraction and the control series.

These external indications of change of attitude should be borne out by the observers' introspective reports. These reports, excerpts from which follow, do in fact confirm the external evidences; substantiate Evans' suggestion, and enable us to account for the equivocal results of distraction and the heterogeneity of our data.

R reports, on the day on which the bell showed the greatest effect of inhibition: "The bell seems to make the reactions more difficult, seems to make the sounds come into consciousness more slowly. Am confused"; and on the day on which it showed the least effect: "Sometimes the two kinds of series [the control and the distraction] seem exactly alike, while at other times they seem so entirely different as to be incomparable. Today they seem alike, that is, I 'feel' that my preparation is the same and that I am giving the same sort of reaction in each."

D reports, when the bell was objectively most effective: "The bell occupied the focus of consciousness; seemed like a blanket spread over all other processes. . . . . the reaction was confused and unsteady"; and on the day when it was objectively least effective (*i.e.*, produced a facilitating effect): "During the distraction-series attention was concentrated on the sound of the stimulus; the bell did not bother me, but actually kept my mind closer to the task. The sounds of the stimulus were as clear during the distraction-series as during the control, where attention was discursive. Seemed unable to inhibit certain associative trains during the control series, whereas they were inhibited more or less involuntarily during the distraction-series."

R reports, during the first series of experiments under distraction by the metronome (the series that gave a ratio of 0.945): "At first I found that the distraction of the metronome upset my determination for sensory reaction, and I think I tended to give muscular reactions. The metronome is very unpleasant." That he did give a different kind of reaction is shown, in comparison with the normal and the other distraction-series that followed, by the extremely low average for that day. He reports after a normal series on the second day (ratio of 1.052): "The reaction without the metronome seems to be more passive than with it. When the metronome is sounding, I have actively to attend away from it. When it is not going, I just take the stimuli passively, and react to them as they come." After a distraction-series on the 6th day (ratio of 1.011): "While there is still some effort necessary to attend away from the metronome, this effort is getting less. In this series, my attitude was only slightly different from that of the preceding [a normal series], yet it was more effortful, more active." And again, after a normal series on the 11th day, when the distraction and the normal series were practically equal: "I cannot notice any difference between these reactions and those with the metronome going. I try to take them all in a passive attitude, just waiting until the stimulus comes without straining for it"; and after a distraction-series on the same day: "I seem to fall quite naturally into the 'set' for reacting with the metronome. It 'feels' natural, and I cannot see that it distracts me. On the contrary, it is rather a steadying agency. In the preparatory interval, its sounds drop out of consciousness."

On the sixth day of the distraction with the metronome, the day with the greatest ratio of the metronome series, D reported after a distraction-series: "Attended actively to the sounds of the hammer, which, when they occurred, varied from clear to very clear. The sounds of the metronome were ever in consciousness. They were rather insistent, varying from vague to clear, and at times becoming maximally clear." On the tenth day, the day with the smallest ratio of the entire series (0.92), D reports after a distraction-series: "Attended passively to the sounds of the hammer, and when they entered consciousness they were maximally clear. The sounds of the metronome were vague during the interval between experiments, and at the times of reaction they were totally obscure."

R reported after a distraction-series during the first observation under distraction by the tuning-fork: "The fork tends to attract my attention. Some effort is required to attend away from it. As a result I attended more to the reactions, and the only thing present in the fore-period to be attended to is the kinaesthetic strain sensations." On the fourth day, when the averages of the control and distraction series were about the same, he reports after a control series: "The stoppage of the fork seems to have no effect. The attitude is just the same with it as without," and on the fifth day: "The fork is not in the least a distraction. It makes no difference in the reactions." Again on the seventh day, the day that shows the greatest difference between the distraction and control reactions, R reports after a distraction series: "Am very sleepy, the monotonous hum of the fork increases the feeling."

D reports after a distraction-series during the first observation under distraction by the tuning-fork: "The tuning-fork very vague, most of the time it is obscure. The sounds of the hammer are maxi-

mally clear. Attended passively and without effort"; and after a distraction-series during the last observation: "The sounds of the hammer were maximally clear; all other processes, in background of consciousness, were vague and obscure."

We have, then, abundant evidence that the attitude of the observers was not constant. It changed from the distraction to the control series, and from day to day. It is only roughly correlated with changes in reaction-times. The correlation, however, is sufficiently close to allow us to conclude that *the effect of a distractor upon the sensory reaction is dependent upon the conscious attitude of the moment.*

We have no adequate data whereby to correlate the different attitudes and the rates of reaction under the conditions of distraction and control. Our observers were not instructed to report upon attitudes, and the information they gave was merely incidental. Since one of the experimenters was serving also as observer, the results were not worked over until the completion of the experiment, and we did not discover the significance and desirability of a report of attitude until it was too late to rectify the omission. From such data as we have, however, it seems reasonable to suppose that the distractors have no effect upon sensory reaction under a passive attitude, while they lengthen the time of reaction under an active attitude. The clearer, the more 'conscious' the distractor, the more active is the observer's attitude, and the more do the reactions differ from the normal; the more obscure, the less 'conscious' the distraction, the more passive is the observer's attitude, and the less does the reaction differ from the normal.

The bell showed the greatest effect of inhibition. The attitude in every case except one was more active during the distraction-series than during the control series; the reaction in every case except one was longer for the distraction-series than for the control. The exception (which we have noted) occurred in D's sixth observation. The apparatus on this day was found broken, and D was obliged to repair it before turning to the observation. During the experiments that followed, thoughts of the apparatus kept intruding themselves. D reports: "I seemed unable to inhibit certain associative trains during the control series, whereas they were inhibited more or less involuntarily during the distraction-series." The distraction 'facilitated' because, under these conditions, a more constant and more passive attitude was maintained than was possible under the conditions of the control series. Even here, therefore, where we have facilitation, we find that conscious attitude will account for the results.

The tuning-fork showed the greatest effect of habituation. After only a few experiments, both observers reported that the sound was very obscure, and that the attitude was practically the same for the distraction-series as for the control series. The differences between

the reactions are no greater than those between the various distraction-reactions, or those between the various control reactions; so that the reaction-times for the two series may be regarded as practically identical, and the variations as due to chance.

Between these extremes lie the results from the metronome, which show the effects of inhibition, facilitation, and habituation, and which may all be explained in the above manner.

Summary and Conclusion

1. The effect of 'distraction' upon the sensory reaction is equivocal. The distractor may inhibit, and lengthen the reaction; it may facilitate, and shorten the reaction; or it may become habitual, and have no effect at all.

2. The effect of the distraction is dependent:

a. upon the temporal relations of the distractor, and

b. upon the conscious attitude of the observer during the distraction.

3. The distractor most resistant to habituation is the intermittent; that least resistant is the continuous.

4. The passive attitude is conducive to a constant sensory reaction of normal length; the active attitude to a slow and variable reaction.

In the light of these results we can largely understand the lack of agreement among previous investigators of the effect of distraction. Distractors of different temporal character have been employed; and, what is still more significant, the observers' attitude has not been standardized, so that their reactions were made under various dispositions. That the importance of the conscious attitude in this connection has not been earlier detected, we believe to be due to the fallacy of conclusions based upon gross averages.

A MEDIUM IN THE BUD*

By G. Stanley Hall

Some ten years ago, before Freud was much known in this country, and about the time I was making some observations on Mrs. Piper with Dr. A. E. Tanner,[1] my colored man, one morning, announced a girl to see me, who did not wish to give her name and seemed "a little skeered and 'cited," and who said it was very important. On going down, I found a very attractive blonde miss of twenty (as afterwards appeared), who with a rather trembling and almost inaudible voice and changing color said that she had been sent to me with a very important message from the spirit-land. I explained that I was on my way to a class and could not stop to receive the message then. She showed some disappointment, but it was finally arranged that she should come to the city from the neighboring town where she lived, the next day, and very readily consented to my proposal that I invite a mature lady and gentleman who were interested in such things (Dr. Tanner and Dr. Edward E. Weaver, author of "Mind and Healing") to be present, to observe, question, and take notes. At the appointed time she appeared and wished to sit in a rocking-chair, with a pillow for her head, a glass of water, and a foot-stool; and very soon the obliging spirits came.

One of the most interesting things about the case throughout was that her mediumship was in so undeveloped a stage that the girl never, for a moment, lost herself, nor was unconscious of what the spirit (whose presence was indicated by a change of voice, which always tended to become her own as the seance proceeded) said. Moreover, the incipiency of her stage of mediumistic development appeared also in the fact that very many of the deliverances from the other world were tentative, often in the form of questions; and she had quite an arsenal of phrases by which, when her own suggestion was corrected

* Perhaps the pith of the story of this case is found in its very last stage where the whole slowly-evolved structure of mediumship was abandoned.

[1] See her "Studies in Spiritism" (New York, Appleton, 1910, 408 p.), especially Chapter XVII, "A Medium in Germ," where this case is very briefly sketched.

or even reversed by us, she would accept our hints and abandon those of the spirits. ("Yes, perhaps the hair was dark but the sun shining on it made her seem a blonde." "The voice was so far away that I could not hear it distinctly and probably it was as you say." "The spirit is weak, came from so far, and for the first time, that I did not get the impression clearly, and now I see it was wrong.") In fact, everything indicated that while the girl, whom we will call Annie because that was not her name, had had to muster much courage to come to me and avow her mediumship, nevertheless her belief in it all was still in a more or less hypothetical stage, certainty alternating with doubt, so that, as the sequel will show, the abandonment of it later caused no great disappointment.

Before describing the sittings and their results, it will be best to outline the conditions under which this nascent mediumship arose, in the light of knowledge which we acquired later, as follows. The girl lived in a small country town, quite apart from the village; was bright, impressionable, perhaps unusually given to adolescent reveries, and was the constant companion of a mother said to have been born with a "veil," and to be more or less of a seeress, communing with spirits. The mother seems to have been estranged from her husband; and mother and daughter, partly because sensitive to gossip occasioned by this separation, had gradually withdrawn even from the church, the chief source of social life in such a place. Hence the isolation of each from the society of all others brought them into almost unprecedentedly close relations to each other. Without the higher education, both were capable, fond of reading, perhaps the mother more about spiritism, the daughter about astronomy, geology, and especially history, some characters of which she later fancied used her as a medium. She had read sporadically much in Chambers' Encyclopedia, and her active mind, on the basis of the facts she had gathered, had worked out certain conceptions in regard to the origin of the earth, of life, the soul, the nature of God, the future life, and the organization of society, so that solitude favored daydreams of greatness, as we see in the life of Joan of Arc but in a very different way. The more tenuous such dreams, the more magnificent they are, and it is not strange that a loving mother, who had no other object of affection than her daughter, and had access to the inmost spirit of her child's life, should watch every fluctuation of mood and every spontaneous concept, every gesture and expression of her face, as an indication of spirit influences.

Not until she was seventeen, did the girl see a real medium;

and then this experience was such as to make her dreams a little more definite as visions, and her reveries were moved several notches up the scale toward becoming realities. The medium they visited not only gave people messages from the dead but insisted that the spirits desired to control the girl herself and had a great work for her to do. Soon, in the very sympathetic attitude of her home, the spirits did come to the girl, indistinctly at first, in the realm of vision, and then in that of audition; so that the girl grew somewhat credulous of clairvoyance and clairaudience, although apparently always with reservations that held her from plenary conviction. Once, there was a vision of a scene which she was impressed was her father's boyhood home; and again a suggestion of the proper hygienic treatment for a sick friend sprang up in her mind autosuggestively. All this was in the family circle, with no thought, even on the mother's part, of using these gifts for financial gain. There can be no doubt that in the later teens the spiritual society, sometimes with the great of history and also with spirits otherwise unknown, of whom there is quite a list (Bertha, Esther, Alphine, Allof, a Martian who had never lived on earth, and many others), was becoming, on the whole, more real or veridical. The very fact that her conviction of their objective existence was not complete but was arrested quite short of any kind of materialization (for both the girl and her mother scorned raps and every kind of apparition), favored abandonment to her wildest aspirations, which could, of course, become exalted somewhat in proportion as they remained tenuous and hypothetical.

Hence we have in this case already some features of that exquisite and romantic effervescence of soul so common to this stage of life, of which Kohl in his "Pubertät und Sexualität (Würzburg, Kabitzsch, 1911, 82 p.) has culled from the large literature upon this subject so many characteristic illustrations. So Annie finally entertained greater spirits, Lucifer, to whom she gave the pet name of "Zezy," also Allof, master of the elements. Lucifer was the prince of all the angels, and to him and his immediate subordinates God had entrusted the conversion and reformation of the world, to fit it for Christ's second coming. All was prepared among the heavenly hosts for the fulfillment of God's far-reaching plans, and these agencies to whom they were now entrusted, in pursuance of the divine will, were about ready to inaugurate this new dispensation. But how? Not by opening the heavens and leading the hosts of heaven down to earth, but there would perhaps be some divinely chosen medium, perhaps a young girl, who

would be shown hidden ways to the highest knowledge, and who might eventually be an agent through whom a new redemption should come to earth, which would unite perfect knowledge and perfect will.

These reveries, no doubt very faint and flitting at first, would almost inevitably, in such an environment and in such a personality, gradually come to focus on herself, conspicuously modest, retiring, sweet, and attractive as she was, for the law of compensation is always at work. No doubt she and her mother long pondered these things, wondering what they could mean, and only little by little did the wonder become focalized and did some degree of conviction and sense of commitment to the guidance of these wise and beneficent spirits occur. She is only the instrument, can only listen and obey. Thus a rich fantasy, stimulated by the warmest maternal sympathy, favored the highest flights of fantasy, and the world of imagination grew inversely and more or less as a surrogate of the normal expansion of interests which were lacking in the environment. Both her disposition and her uncertainty held her back, while her mother's constant, if gentle, urgings, impelled her forward, to settle the great question of whether or not all this inner psychic structure was veracious or made only of the stuff of dreams. This, at least, was our interpretation of what had led up. She had long pondered, and it was in this stage of her development that she chanced to see in the daily papers an account of lectures on the psychology of spirit phenomena that had been provided to be given at Clark University under my direction; and hence she sought me out.

The above represents all the motivation that we detected in the early seances, in the amazingly frank descriptions of "this girl," in the past and present, by some of the spirits that possessed her, and in data that we gathered from various other indirect sources. Surely it seemed that here we have no trace of any sex motivation, and in this naïve and innocent soul the deliverances of the early seances contained nothing whatever to suggest ever so remotely any erotic factors; nor, indeed, anything else abnormal. On the other hand, the center of interest to us seemed to be in the far-flung and exceptional magnificence of the idealistic imagery, which makes the teens the golden age of imagination. The circumstances that surrounded the girl were homely and obscure, and in the neglect and critical attitude of neighbors and country gossip, she had saved her sense of the value of her personality by evolving an inner world that more than made up for all that she missed from the outer reality, from which she had so

effectively taken flight. No other members of her family, save her mother, seemed to have been dominant in her development to any appreciable degree.

Coming back now to her first seance with us, never before, save in the presence of her mother, had she communed with ghosts. Now, in the presence of three university people, who sat in a crescent about her, waiting to hear and record what Lucifer was to reveal to the world, we can well imagine that her bosom must have heaved with a sense of achievement already, and that in her own conscious personality, which was never for a moment obscured, she must have reached about the acme of conviction in her transcendental guise and in her own mediumship. Even the musings of her twilight hour, of which perhaps even her mother had not been a full confidante, took bolder outlines, and the imaginary companions which she had chosen sustained all her falterings. But oh, the naïveté and insouciance of sacred simplicity! This and her own charming personality was able to keep the manner and tone of her little circle respectful and even sympathetic, and enabled them to jot down many of her dicta, which must have brought her own faith in spirits to its very culminating point. To have us record these crude platitudes in regard to the heavenly hosts, God's plans for man, and the nature of the nebulae, the conditions upon Mars, the development of man and mind, all given out in the most simple, unabashed, and unconscious way, as this soul of young womanhood was laid bare, until we almost shrank from listening to intimate revelations about the most confidential matters which the spirits told us, in regard to not only the outer but still more the inner history of "this girl,"—all this we saw in the early sittings she was accepting as evidence that her mission to us was succeeding beyond her wildest hopes.

Her bottom purpose grew more and more clear to us; viz., to so convince us that she had a revelation for the world, that we should summon a larger group of the most eminent scientific experts to listen, question, test the truths the spirits were revealing through her, that the world would come to realize their existence. Her ambition was to be an apostle of spiritualism in the world, and to be recognized as such. She was nothing; the cause was all. Even the unfavorable revelations about herself seemed at first only designed to bring out the power of the spirits, all the more because of contrast with the insignificant medium they had chosen. If they could do this with such a girl, what might they not do with those in every way her superior?

Our only attitude, therefore, was at this stage to express frankly to her, and also to her control, our doubts. We demanded revelations of something known only to one or another of us personally. This was pronounced fair and many attempts of this sort were made. I was said, *e. g.*, to have drawn my baby brother in a box cart and hurt him, and although he was younger, he arose in his wrath and gave me the surprise of my young life by a drubbing. I was said to have lost a cigar behind a desk; as a baby to have performed antics with my mother's bustle. The spirit of the founder of the university was rung up, and although he came reluctantly and could remember only in the vaguest way (because he had other greater things to concern himself with in the other world), he at last recalled a number of episodes and conversations with me. The girl, or the spirit control, which was only a somewhat different level of her own personality, seemed to have a certain degree of implicit confidence in every scene and image that popped into her mind. It must have been true somehow, somewhere, out of me; otherwise it would not have occurred. Along with this conviction there went also, in the incipient mediumship of which we have here so rare an illustration, the most acute suggestibility, so that every inflection and expression of the face of each of us interlocutors modified and even negated any of these rank spontaneities in the medium's mind. Our attitude was not to affirm or deny each suggestion or test as she presented it, but rather to assume an interested and waiting air, and jot it down; so that her environment might be on the whole sympathetic, as was necessary if the sessions were to develop aright. The least expression of scorn or any blank negation would have ended everything. As the sessions proceeded, various tests were discussed. The medium was inclined to believe at first that her controls could tell how many oranges of a basket had been poured on a table behind her, a test, the successful accomplishment of which a five-thousand dollar prize had been offered. But later, after preliminary experiments at home, Annie reported that this could not be done.

Reading sealed messages was not impossible, but not quite worthy of the attention of so lofty a spirit as Lucifer; while levitation and raps were still less so. After a number of sessions, the persistence of "Zezy," however, became very urgent that we should declare whether or not we would call a conference of savants, and he threatened to take the medium to another circle, less incredulous, and leave us unless we were about ready to act. The medium, however, was more

ready to see the force of our insistence that scientific men would be more rigorous than we, and that if we were not yet convinced, they would be still less so and the end would be disastrous to the cause, to say nothing of the medium. Thus in the early stages there was nothing to suggest anything Freudian, but there was simply the earnest desire to convert the world and prepare it for a new dispensation.

At this stage several courses seemed possible. (A) We might continue an attitude of interest and sympathy, perhaps enlarging our circle to meet the medium's wishes, and to encourage her to do her best with one or several of the controls from among those she had evolved herself or which we had invented (for the origin of them seemed to make no difference). Under the stimulus of the experience thus provided her, we might, had we the time, patience and purpose, have helped her evolve a very high quality of so-called mediumship, and launched her upon a career of self-deception and of being investigated by psychic researchers, and she might thus have become in a sense a rival of Mrs. Piper. The already incipient change of her psyche might have gone on until Annie and "Zezy "parted company; until S. B. had taken on the lineaments of a third personality, while we observed and reported the stages of all this processional. This girl's mediumship seems unique in that it did not come suddenly or involve oblivion of one state in another, but for memory purposes there was an almost complete overlapping. This first course we could not pursue for we deemed it unethical, and not in the interests of the patient in this case, although let it here be distinctly said that there are undoubtedly cases where such a projection and materialization of certain unconscious impulsions of a patient might have a high therapeutic value. The mediumistic state should never be cultivated by the physician unless he is absolutely certain that he has the reductive. Like transfer, this fixation upon a spirit thought objective may be helpful at a stage, but its processes need far more study.

(B) We might have taken a standpoint typically represented, perhaps, by the hard-hearted practical physician, and told her bluntly that her spirits were delusions, and warned her of her danger of neuroticism, of self-deception, of entering upon a career of charlatanism, playing upon the credulity of those who have lost friends, etc. She could hardly follow this course, if for no other reason than because it would have involved a rude break with her mother, for she was not yet ripe. It proved in the sequel still more fortunate that we

did not take this course, because it would have involved the shock of another rupture, viz., with a lover, although his existence was not yet suspected by us, as will be seen later.

(C) The third course, which we chose, was to go on and evoke all there was in this mediumistic diathesis to the very uttermost, until both she and we could see all there was in it, and then when it was fully documented, to try some kind of a Dubois persuasion cure. It might prove all a romantic bubble, which would burst of itself if sufficiently inflated, or again, perhaps a new way, as yet unperceived, might occur to us as we proceeded.

As on the whole both the medium and we were ready to go on, we asked for a few imaginary spirits that we had designed and given fictitious names to, particularly one S. B., who it was intimated was my niece, a girl graduate, attractive, interested in social settlement work, etc., and whom at last "Zezy" brought to us. She had come four million miles and resisted persistently all attempts to tell anything about me, merely accepting rather shyly most suggestions of incidents that I feigned to remember with her, a young man, a boat-scene, a picnic, a gold watch and chain I had given her, a quarrel, a green pocket-book, a violin or guitar or something with strings, which the medium accepted the suggestion was really a mandolin, though she finally admitted she was mistaken about all this, but said it was another girl, J. B., also a fictitious character, or perhaps M. C. or H. B., other of our inventions. But S. B. could not get away from the medium herself, and she proceeded to reveal gossip about the various members of her family, some of which was in the highest degree discreditable, the medium meanwhile, although understanding perfectly everything and showing a certain amount of shame and confusion, flushing and breathing deeply, not only at things said about others but entering upon a more or less detailed story of the love-affair of the girl, and stating roundly that her motive in all this mediumship was to get a hearing at which a man with whom she had fallen in love could be present and would be impressed, as she wished him to be, with her sagacity, ability, importance, etc. S. B., in fine, gave us to understand that the many and very serious clouds which had rested upon the girl and her family had prevented the lover from declaring himself, had made him reluctant to accept the girl as a pupil in the art he taught, and that if we could only arrange to invite him with the savants to see the girl in the midst of her seance, with the wise men taking notes, all his scruples would be

overcome and he would hasten to avow the love which he undoubtedly felt, but had been hindered from expressing.

Now the whole situation stood forth in a new light. An erotic motive, of which there had hitherto been no hint, appears to have been the dominant one throughout. The man, apparently in every way worthy and without in the least having committed himself, must be won, and the suggestion was that all this incipient mediumship, with the conceptions of greatness, was a dream fantasy that had sprung out of the unconscious from the fundamental motive of winning a mate. In previous seances it had become more and more apparent that the girl had already cherished the secret dream that she was to be a new holy mother, that the new dispensation was to be inaugurated by a child whom she was to bear, so that all the issues of history were to focus in her motherhood. The world was to be re-redeemed by the fruit of her own body, and it seemed not improbable that she justified her own subtle methods of making advances in this initiative to win the man she loved, because the issues were as momentous as the salvation of the world. He was doubtless to be the father of the new Messiah and perhaps if all her wishes were carried out, he would listen to the call and the motive of duty might supplement that of love in impelling him to woo her.

Now we had a new situation, a new goal, and a new motivation revealed. These highly colored accusations of S. B. (which were really self-accusations, because Annie knew well all that her control said), and the more or less unconscious purpose of the control (representing the more or less unconscious layer of the medium's ego), were to enlist our sympathy with a greatly misunderstood and misrepresented maiden, whom malicious and truculent gossip had discredited, to right herself in the eyes of one to whom she had given her heart with all the abandon of first love, and with an unusual idealism. An audience of savants listening to her inspired revelations was the dramatic scene she had evolved in her fancy, as the means of his conversion from criticism and aversion to admiration and love. The more squalid the details of her physical and moral environment, the more glorious her triumph. Her father was made out a criminal, and even her mother was sacrificed to the surprising extent of having been the subject of the most vicious scandal, with many circumstances of times, places, names, etc., which we suppress. Thus for S. B. the girl was made a most pathetic and innocent victim of an ostracism that was cruelly unjust and

nothing less than pathetic. At times, as S. B.'s revelations proceeded, we were almost aghast, tried to stop the swelling tide, but in vain; Annie felt it coming, for she had flushed, breathed deeply, and showed acute agitation as the *chronique scandaleuse* proceeded, in which she was both audience and actor. She could even remember and report most of this matter in her normal state afterward. The motive of it all grew to seem to us more and more a pitiful and almost despairing attempt to arouse our pity, so that we might invite the scientists to right the wrongs of the girl, or if not, we might devise other means of bringing her lover back. Indeed, we did later discuss other possible means of bringing them together for an interview, in which both S. B. and Annie were eagerly interested. We said if he was invited to a conclave of scientific men, he might feel out of place, wonder why, and finally perhaps suspect that she had planned it all to attract him, and thus turn away feeling that it was a subtle but perhaps somewhat unmaidenly method of making advances.

Finally, we suggested that perhaps he was not a believer in spiritism. This was manifestly a new and somewhat startling proposition. We followed it up by intimating that possibly he might have a deep prejudice against it, as some people certainly did, so strong that even an imposing array of professors sitting at the medium's feet could not suffice to overcome it. This ended the session, and she went away saying that she had reason to think that he was a believer. She left subdued, however, and pensive, and no longer demanding the high audience her control had been so insistent about at previous sittings. She wondered if it would be feasible to find out what he thought of spirits.

This girl evidently loved her own diathesis and the experiences it brought, and this seems generally to be the case. When we ask why, it is not entirely sufficient to say that the priestcraft motive has brought respect and power in the past because of its function of mediating between two worlds. This has, in the past, given it great charm and may still contribute to the attractiveness and exhilaration of this state. These experiences also doubtless stimulate and enlarge the ego by widening experience, but there is another source of fascination, not yet, to be sure, fully analyzed, but which is found in the love of the utter abandon involved in this state. Inhibitions are thrown to the wind. While the normal ego is controlled, the control can let itself go and express the very deepest and most secret things in the soul, often with

a frankness that ordinary social conventions would make impossible. Thus there is a sudden freedom from responsibility and sensitive, shrinking, repressed natures, who would above all things dread to shock or violate convention in phrase or manner, are freed from the necessity of even being agreeable or primly proper, which must often become irksome, hedged about as they are by so many senseless taboos. In the trancoidal state these are all removed, for the nonce, from one level of her soul, and she can blurt out things which ordinarily maidenly modesty would never permit her to say or hear. Such tender and delicate girls often feel themselves possessed by some rugged, potent and often uncouth male spirit, and delight to swagger in diction and manner, to be blunt, slangy, to uncork and vent elements of conduct and psychic action-types for which nothing in normal experience gives such opportunity or such incentive. The girl is thus using new powers and in some sense may be the better for it.

The instinct which often seems to dominate is to drag up into the light of day their own most private thoughts, feelings, aspirations, imaginations, which in the normal state would be intimidated into silence, if not repressed into the unconscious. Her soul is generally hidden, but now it is open like a St. Martin's stomach, into which it is possible to peer, so that we have here a new domain open to psychological science, which, when it is understood, will be found to be a very essential factor in the mediumistic diathesis.

Psychic researchers to-day represent the last potent stand of about all the old superstitions of the past, against which science has contended. The next generation will be hardly able to believe that prominent men in this wasted their energies in chasing such a will-of-the-wisp as the veracity of messages or the reality of a post-mortem existence, which they no more prove than dreams of levitation prove that man can hover in the air at will. It is the diathesis of mediumship to over-work the projection mechanism, and put forth its reveries as if they were revelations, and really had been valuable instead of being simply and solely subjective. This girl regards any impression that springs up as a result of mediate association in her mind as objectively true, and yet nothing is so plain as that she plays both rôles of listening to her own oracle, inebriated by her own elixir vitae. She was able to feel that my fictitious niece, S. B., was betraying her, so that there was a strange combination of girlish naïveté and an almost incredible subtlety and artifice. S. B. laid bare many of these mazes in a way twice pathetic, first because

of the narratives themselves which if true, (as later investigation seemed to indicate, many, if not most, of them were) were bad enough and must have caused very great pain when they happened and would be distressing to remember; and second, because of the pain now of having all these repeated to outsiders. Over and over we are reminded by S. B. that nothing of all she has told is said by the medium herself, but it is the control who knows and betrays, because believing it to be for her good. So intent is S. B. upon this exposure, that she cannot be brought to leave any word for her mother, or give me or any other mundane thing much attention. This phantom niece was most intent upon gentle overtures to overcome obstacles, to allay suspicions, and this was why she had come so far and was so oblivious of her quondam friends, now that she was here, from out of the vast depths of space. Perhaps we had summoned the spirit of some real person who had lived under the name we chose, and she was not voluble with reminiscences because out of her sphere of acquaintances. We thought S. B. was not even a shade, but only a verbal shadow of a shade, and perhaps her silence ought to be interpreted as conviction of our fraud. The medium set the scene, brought out and hung up the wardrobe on our dummy, but no personality came to put it on or to really interpret the rôle.

But if this be so, how could our lay figure be so informed concerning our medium, who knew no such person; and why should she be so intent upon her errand of mercy? Can even a lying thought in a mortal brain or mind create a new individual soul out of nothing, as Mrs. Eddy thought mortal mind creates and destroys all diseases, fear, death, etc.? Perhaps false thoughts may originate personality or make a nomen into a numen, entifying empty sounds. Man has done this with countless mythological persons, some of whom have been canonized as saints. Thus perhaps my niece, at first a mere name, warmed into life, as the marble Galatea, when she stepped down from her pedestal a human being. Perhaps some real soul (since all of them want to get back to life), assumed a rôle of the name we gave, and since there was no Sarah Beals some accommodating spirit stepped forward to take her place. If this is the case and some subtle spirit pressed into my own skeptical sphere of thought, under the guise of a lie, because there was no other way, it would seem that the fact that I was willing to imagine a spirit gave him his opportunity, or in other words, made my defensive armor vulnerable at this point, so strong was the passion of

this disembodied soul to make contact with this world and to justify her *raison d'être* here by an act of mercy. Thus our clumsy strategy was made an open door of opportunity to succor a maiden in distress, and perhaps thus the spirits used our frailties to accomplish their own ends and overrule our purposes, ordaining help and truth out of our falsehood as God is said to make the wrath of man to praise him.

Very soon after the last session, Freud and Jung spent a week at my house, while lecturing at the University. I mentioned the case and they expressed a desire to see the girl, and she obligingly came in; in a short interview with her they at once diagnosed the true nature of it all, and to my surprise she frankly confessed that her chief motive from the first had been to win the love of her adored one, and said that if he would take her as his pupil, all she wished for might thus be accomplished without the aid of spirits, although even this, it appeared, he had refused to do. The audience with a group of psychic researchers she had succeeded in arranging "in half an hour," while we had not been able to gather scientists "in weeks and months," had entirely failed to help her toward her goal. The erotic motivation was obvious and the German savants saw little further to interest them in the case, and I was a trifle mortified that now the purpose so long hidden from us was so conscious and so openly confessed. They suspected a possible incipient dementia praecox, which we were a little loath to accept, because we had urged upon her that it was better to be her own richly endowed personality than to be the mouthpiece of a dozen magnates of the spirit world.

Some weeks later, the girl called for the last time and said very briefly, in substance, that she had fallen in love with another and very different kind of man, and that neither he nor she cared to have anything more to do with spiritism, adding that she had come to believe in it no more than we did, that she had always accepted it with reservations, and was now very happy. Since then (1909) we have seen or been able to hear nothing of her. This seemed perhaps a happy issue.

There is in all the wide domain of psychology perhaps no such *terra incognita* as the heart of the adolescent girl. I have collected a few data on the subject ("Educational Problems," Chapter VI, which outlines perhaps a score of cases illustrating the very prominent rôle such girls have played in the history of spiritistic phenomena from the Fox sisters on; see also Chapter X, on "The Budding Girl," and

Kohl's "Sexualität und Pubertät," which epitomizes many German works touching this subject).

Hers was a divided soul. She listened to the spirits and yet doubted them and never entirely surrendered herself to their control but scrutinized carefully all they said. The only affectation of ignorance on her part of their utterances was of the painful things S. B. had said about her and her relatives, and yet her flushing, tremors of voice and very evident embarrassment showed that she had heard and understood, reacting to it all as any normal girl might have done to such narratives so closely touching her home, her relatives, and herself. She doubted and had renounced belief in the love of her idol, but her chief control, "Zezy," had pertinaciously insisted that he loved her and wanted all along only the clearance of her name and opportunity to urge his suit. There was abundant evidence, too, that between sessions she had practised at home with the spirit personalities we suggested to her, and had evolved some very clear imagery as to what they were like and also had more or less developed them into individual rôles and had images of certain incidents with such Cartesian clearness and distinctness that they seemed to her to be certain, *e. g.*, the description of her father's childhood home, certain of Mr. Clark's pictures, my smearing my brother's face with jam, a high cliff with a fence around it, a tree with four roots, etc. These spontaneities were confidently recited in an almost challenging way, as if their truth were unquestionable, and the only point was whether we could or could not remember them. Very different were the new spontaneities or the suggestions that came from us for the first time at a seance. Over these she always hesitated, accepted them tentatively, while they were indefinite, and were very easily transformed, sometimes into their very opposites, at the slightest hint from us.

Perhaps all the light shed by this case is darkness. The adult, painstaking, male mind may be hopelessly incompetent to understand the effervescence of the ephebic girl, for he has very often been at her mercy. Perhaps in all girls at this stage of life there is a period of hysterical longing to be the center of attention that stops at nothing to fool wiseacres to the top of their bent, as Luys' favorite patient did him. Perhaps our subject never believed in spirits but cultivated them for years as a lark, or a kind of experiment, and then later used them more seriously as means to an erotic goal. Perhaps her final avowal of another love and of the abandonment of all concerning ghosts was a ruse or a fiction to bring to a definite

close her romance with us, while she may have held to it throughout. The second lover was perhaps little more than an imaginary companion introduced to close the incidents with us, and he may have been as unreal as the spirits themselves. Or finally, it is just possible that some credence in imaginary converse with the great departed we read of in history, or with angelic or planetary souls, may be a mode of developing the soul of the adolescent girl by giving vent to her struggling, very diverse, and too often mutually suppressed impulsions, and that this helps on to a fuller and a more rounded development. Possibly, too, this cult may sometime suggest a new method of investigating this tendron or *Backfisch* but mysterious land of fancy.

A PSYCHO-ANALYTIC STUDY OF AUGUSTE COMTE

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Escaping from the narrow field to which they were first limited, the psycho-analytic theories have come to have an universal application, for they have built up a causal relation in human conduct. In addition to the old descriptive psychology, we have now what Crile in his *Origin and Nature of the Emotions* has defined as a "science of man's activities as determined by the environmental stimuli of his phylogeny and his ontogeny." (2:p. 154.) The repressions, the complexes, the symbolisms which Freud and his followers have found in their analyses of hysterical and insane patients, are present in the mental life of every human being. There are only two distinctions between the normal and abnormal mind, —first, the intensity and number of the repressions and complexes; second the methods by which this psycho-physical energy finds an outlet. The madman and the genius are activated by the same motives, but the insane man escapes from the painful realities of his life by means of his delusions, while the poet who has been unhappy in love finds consolation in the writing of exquisite love lyrics.

Freud, Jones, Pfister, and others have given us searching analyses of men whose names stand high in the worlds of literature, art, music, statesmanship and mysticism; Segantini, Da Vinci, Andrea del Sarto, Dante, Lenau, von Kleist, Wagner, Bonaparte, von Zinzendorf, etc. (6.) The field of Philosophy alone has remained almost untouched. Von Winterstein, to be sure, has said that the philosopher is actuated by two fundamental motives: first, the eternal mother-longing, which is manifested in the desire to find some ultimate principle, some lasting reality, as an anchor in the constant flux of life; and second, the narcissistic impulse which leads the philosopher to make himself, and incidentally all mankind, one with the universe and with God. (19.) Yet while these two motives may apply generally, they are insufficient to explain individual philosophies. Hitschmann, in his masterly analysis of Schopenhauer, has shown that the whole pessimistic philosophy of the latter was determined by his childhood, and that the transformation of his mother

complex into its ambi-valent form of hatred was responsible for his attitude toward all women and toward society in general. (10.) Moreover, it is not narcissism, in the strictest sense of the term, but rather the will to power which is the basis of much philosophical identification with God. Nietsche, as Jung has pointed out in his *Psychologie der unbewussten Prozesse,* is the quintessence of this power type, since he goes so far as to make man himself the supreme overlord and to dispense with God entirely. (11: pp. 44-48.)

Auguste Comte, French philosopher and founder of the science of sociology, is no less interesting a figure for study in the light of psychoanalytic interpretation than are Schopenhauer and Nietsche. The unique quality of a mind which could construct the Positive Philosophy, and found a new science of society, yet which could later propose a cult or religion which, though profoundly truthful in its conception, was arranged in a form utterly fantastic and absurd, has long puzzled the psychologist and the student of philosophy. Many explanations of Comte's change of character have been suggested, but there have remained unnoted or misinterpreted certain forces in his life which afford a more rational explanation than any yet advanced. It is these more fundamental causes which this paper attempts to point out.

Auguste Comte was born at Montpellier, France, January 19, 1798. His family was in moderate circumstances, his father being a receiver-general of taxes. His mother, Mme. Rosalie Boyer, is characterized by Robinet as "a woman of great heart and noble character." (16: p. 115.) Like her husband, she was a devout Catholic and a staunch Royalist; but at the age of fourteen Comte had repudiated all sympathy with either belief. Instead of growing up with his brother and sister under the gentle influence of his mother, Comte was placed in the public school of Montpellier, where, though scarcely nine years old at his entrance, he made rapid progress, and was soon recognized as one of the brightest pupils. So great was his ardor for study that in three years he had completed the whole course in literature. At the age of twelve, then, he began his study of mathematics, in which branch he became so proficient that at sixteen he passed the examinations for the *École Polytechnique,* receiving one of the first places, although he was still a year below the age required for entrance. Meanwhile, one of his old masters at the Montpellier school had become ill, so Comte employed his enforced year of waiting in giving a course of mathematics there.

In 1814, Comte entered the *École Polytechnique* at Paris. Although only seventeen, and handicapped by an immature and sickly appearance, he soon showed that he possessed a mature and thoughtful mind. Brilliantly successful in his mathematical studies, he yet had much leisure time, which he devoted to the study of philosophy, the history of the French revolution and other political studies. Thus there was roused in him the first feeling of the necessity for social reconstruction and political reformation.

By comrades and teachers alike, Comte was considered an exceptional character, of superior mental ability and unusual decisiveness. But the old spirit of insubordination which he had shown even in his early school days at Montpellier, was still strong within him. His rebellious career at the *École Polytechnique* ended in 1816, when he became ringleader of an insurrection which broke up the school and caused him to be sent home under the surveillance of the police. The police supervision was neither very strict nor very long continued, but his notorious dismissal from the *École Polytechnique* proved to be a serious obstacle to the continuation of his career. However, he soon returned to Paris, where he managed to earn a living by becoming a private teacher of mathematics, and resumed his studies. He took up especially cosmology, biology and history, thus building up in his own mind the scientific hierarchy which he afterward formulated in his Positive Philosophy.

In 1818, Comte met Saint-Simon, with whom for the next six years he was to be associated as secretary, collaborator and pupil. Saint-Simon's teachings were founded on two ideals which he had only vaguely formulated: first, to establish a demonstrable faith by replacing theology with science; second, to make the proletariat a part of society by replacing war with industry. He had not, however, the intellect to take the first step toward realizing these ideals; and it remained for his more brilliant pupil to systematize and reduce to some logical form these disjointed concepts. But as Saint-Simon grew to turn more and more to theology and metaphysics, the friendship between the two men became cooler, until finally, in 1824, Comte broke off all relations with his teacher.

On February 29, 1825, despite the protests of his family and friends, Comte married Mme. Carolin Massin, with whom for some time he had been having relations in her capacity as "fille publique." Their whole married life, until their final separation in 1842, was a series of misunderstandings and a

constant source of unhappiness. Comte was an intolerable domestic tyrant, absorbed in himself and his work. His wife had no patience with his disregard of material success and prosperity, and relieved the tedium of her domestic life by frequent liaisons with other men. Altogether, Comte's personal experience was far indeed from the ideal marital relation of his writings and of his social philosophy.

In 1826, Comte began a series of lectures setting forth his Positive Philosophy, but after the first three had been given, this work was interrupted by the first of the three "mental crises" which have been so variously utilized in explaining the peculiarities of his life and work. This first cerebral attack was prolonged and severe. It led him to suicidal attempts, and necessitated his confinement in an institution where he could receive proper care and attention. By 1828, however, he had fully recovered, and was able to resume his course of lectures, and to begin his *Cours de Philosophie Positive,* the first volume of which was published in 1830, the sixth and last in 1842.

In 1832, Comte became first, lecturer at the *École Polytechnique,* and then one of the examiners. Four years later, he was given the principal chair of mathematics in that institution. But his period of prosperity and recognition was short, for the publication of his Positive Philosophy, in which he had made sociology highest of the sciences, brought him once more into disfavor, and caused his second dismissal from the school. Condemned by the theologians, abandoned by the scientists, misunderstood by the Revolutionists, unknown to the mass of people, cut off from his family and deserted by his wife, Comte lived a life of complete isolation until in 1845 he met the woman who was to play so vital a part in his after life,—Mme. Clotilde de Vaux. Her physical charm and loveliness as well as the grace and intelligence of her mind, combined to make Comte love and revere her. Both were bound legally to mates whom they would never see again, but morally both were free. An equal isolation, an equal need of affection, drew them together, but an ideal of marriage unique in the purity and idealism of its conception, never permitted them the fullest expression of their affection. Throughout the short year of their companionship, until Mme. de Vaux's death in 1846, their love was always platonic, their comradeship ever on the spiritual plane. Yet it is to Mme. de Vaux's softening influence that Comte attributes his abandonment of the strictly intellectual and scientific position which he had maintained in his Positive Philosophy

for the evaluation of the emotions and the affective life which he expresses in his Positive Polity. This is the work which he terms an expression of his second career, and which was completed during the years from 1851 to 1854. Meanwhile, in 1849, he had published the Positivist Calendar, and in 1852, the Catechism of Positivism. He died in 1857, the cause of his death being a cancerous growth in the stomach.

In order to understand the marked contrast between Comte's mental attitude during his early years and that of his later life, we must keep in mind Jung's hypothesis of the two psychological types, the introvert and extrovert,—the thinking type and the feeling type. (11:pp. 9-94.) Two motives, says Jung, have previously been advanced as the basis of all human conduct. The first of these, the sexual theory, was advanced by Freud, and assumes that the great complex of instincts and emotions which center around the reproductive functions is the guiding principle of existence, that there is no joy in life equal to the joy of feeling in oneself the creative power, whether it be expressed in its original biological form or on the higher plane of productive labor. Our modern civilization has imposed upon the human race an unreasonable control of these natural tendencies, not only through economic pressure but by means of new social and moral standards. Herein lies the whole root of mental conflict, for man's primitive passions are constantly rising against the moral ideals which he attempts to impose upon himself. The erotic desires of the subconscious are incompatible with conscious morality, and hence grows the neurosis, which is inseparable from the sexual problem of our age. The neurotic is merely trying to solve the universal problem in his own personality.

The other theory of human conduct is the Adlerian postulate of the *Ichtrieb* or *Wille zur Macht*. In this statement, the instincts which lead to the preservation of the species are subordinated to the impulses which lead to the fullest development of the individual, even at the cost of racial welfare. The psychic expression of this motive is an inordinate craving for superiority and a desire to be and to do all things; but since this lust for power can never be fully satisfied, it, too, becomes the basis of the neurotic conflict.

The contradictory viewpoint of these two theories is explained, according to Jung, by the fact that both are the product of a one-sided psychology. The truth is that both principles are present in every mind. The human soul, sick or well, can never be explained by one motive alone; it is neither wholly racial nor wholly individualistic, but what these

two have made it and will make it. It is necessary, therefore, to build up a new hypothesis which shall rest on a broader foundation than either of these theories, and which shall include both of them, hence his idea of the two psychological types,—the introvert or Adlerian type, and the extrovert, or Freudian type.

"Each of the two has one function especially well developed; the introverted type uses thought as an adaptive function and thinks of its conduct in advance, while the extroverted type feels itself into an object while it acts. . . . . The neurotic conflict always occurs between the adapted function and the non-differentiated and for the most part unconscious, companion function. That is, in the introverts, beween thought and unconscious feeling, and in the extroverts between feeling and unconscious thought. When in the thinking man there comes a demand which he cannot master alone by thought and without differentiated feeling, then a pathogenic or traumatic conflict arises; and conversely, with the feeling man, when he faces the problem that demands differentiated thought, then comes his moment of crisis." (11: pp. 73 and 77)

These two psychological types have long been recognized, but Jung is the first to seize upon their real significance. William White, in "The Mechanisms of Character Formation," describes the extroverts as characterized by rapid reaction, prompt production, and an abundance of ideas and projects. They are admirable teachers, having a contagious enthusiasm and exercising great personal influence on their pupils. The introverts, on the other hand, are of slow reaction, produce with much effort, live removed and shut up in themselves, and give their life to the achievement of a perfect work which often secures them a posthumous celebrity, (21:p. 217-221), William James, Müller-Freienfels, and other psychologists have described similar types, differing only in applying to them other terms than introvert and extrovert.

Although every person has a slight leaning toward one type or the other, it is obvious that both impulses must exist in everyone. The passing on of the torch of life demands that the individual have both the egoistic instincts which lead to self-preservation and which are strongest in the introvert, and the broader impulses of the extrovert which lead to racial preservation.

"Civilized man," says Jung, in *Die Psychologie der Unbewussten Prozesse*, "leans a little more toward one motive than the other. For the fullest expression of life, a balanced interplay of both tendencies is necessary; together they form a complete personality." (11:p. 75.)

The two tendencies are, in fact, in a sense ambi-valent; the

individual is constantly oscillating between them according to the necessities of his environment. As will be seen later, it is in this ambivalent quality of introversion and extroversion that we find an explanation of Auguste Comte's peculiar mental reactions.

One other general concept is necessary for the proper understanding of Comte's character before we consider in detail the interacting forces which shaped his destiny,—the idea of religion as a necessary psychic function. Here, again, it is Jung who has recognized the vital significance of a fact which has been variously stated by other thinkers. Below the subconscious of Adler and Freud, which is the realm of childhood experiences, and desires, whether of infantile sexuality or infantile will for power, lie the deeper levels of the psyche which contain our phyletic memories and experiences, and which must also have their proper outlet. The chief means by which this "absolute subconscious" finds expression is through religion, which is nothing more nor less than a projection of man's own deepest emotions.

It was this projection of personality which Durkheim unwittingly described as the basic principle in totemism,—the idea of a mysterious, impersonal power, an all-pervading force, which the Australians call "Arunkulta," the Melanesians, "Mana," and the Iroquois Indians, "Orenda." (20.) Carpenter, too, in *The Gods as Embodiments of Race Memory,* has given us a beautiful exposition of this viewpoint, in which he does justice to Spenser's ghost theory of religion, and also shows the deeper underlying forces emphasized by Jung:

"Current explanations of the gods—as from generalisations of nature-phenomena, or idealisations of heroic men and women, modified by traditions, memories and dreams, and complicated by mistakes in the meanings of words and names,—are certainly suggestive; but while they help us to understand the origin of the forms of the gods, they fail almost entirely to account for their astounding power and influence, or to explain why to the savage and untutored mind mere generalisations and abstractions should have acquired such intense reality. Such gods must represent some real force influencing mankind. The figures of the gods are apparitions or manifestations of the conscious life of the race in the mind of the individual. . . . . How many times in past ages has the sun broken upon our primitive ancestors, bringing relief after the darkness and terrors of the night, and giving a sense of joy and comfort. How continually has this sense grown, with reverberant intensity, in the successive generations, till at last in some more than usually subtle and sensitive soul, it has broken into a strange consciousness of a presence,—the presence, in fact, within that soul, of the myriad life and emotion of those that have gone before. There is a personification, not because we are

really coming into touch with the sun or moon, but with the great subconscious mind of the race. . . . . 'The god or goddess is but the composite of numberless race memories, a beautiful, luminous ghost made of centillions of memories.' Throughout the ages, man has sought woman, woman man, and in the very nerve plexuses of every youth and maid there is imbedded a composite sex ideal bequeathed by heredity and formed by superimposing various figures upon each other. So, too, the battles of the race have stamped within us the picture of the hero. These composite memories dwell in our very nerve centers of love, pugnacity, sympathy, etc., just as the Gods dwell in their temples, and when some object of our environment rouses these sleeping recollections, we feel the presence of the gods. . . . . The figure of Christ is not merely the ideal of humanity which we should strive to emulate, he is also the memory of all the suffering, all the love, all the pain we have borne in our phyletic development. . . . . The life and memory of the human race, the vast accumulation of experience in the slowly evolved nervous organisation of mankind, form the Olympus whereon the Gods dwell. Each unit mind is an offshoot of the racial mind; each unit body is an offshoot of the racial body; and as far as, for each individual, his mind and body register the memory of the race, they form the gate of entry into this other world." (3: pp. 259-279).

This racial memory of Carpenter's is synonymous with the absolute subconscious of Jung, and both authors have recognized that it plays a vital part in our religious life. The poets, moreover, whose sympathetic and sensitive natures often permit them to grasp in one intuitive flash the underlying principles which the scientist is laboring to explain, have long since recognized that religion is but a projection of the human soul.

"*Deus est in pectore nostro,*" wrote Ovid; while in the *Rubaiyat of Omar Khayyam* we find the following significant lines:

> "I sent my Soul through the Invisible,
> Some letter of that After-life to spell:
> And by and by my Soul return'd to me,
> And answered, 'I myself am Heaven and Hell.'
>
> "Heaven but the Vision of fulfill'd Desire,
> And Hell the Shadow from a Soul on fire,
> Cast on the Darkness into which Ourselves
> So late emerged from, shall so soon expire."

It is not strange, however, even with the aid of the poets, that it has not been generally recognized that our gods and demons are but the reflections of our own virtues and vices, since the distinction between the self and not-self is at best developed at a relatively late period in the life of the race and of the individual. Students of primitive mankind have found our ancestors firm in the belief that their shadows and

reflections were a part of themselves, and that their dreams were real experiences. G. Stanley Hall in *Some Early Aspects of the Sense of Self,* has shown that children commonly fail to connect various parts of their bodies with their own personalities. (8.) It is no wonder, then, that we have not realized that our deities become real to us only as they are extensions of our own mental processes.

At this point, the bearing of Jung's statement that religion is a necessary function of the human psyche becomes clear. According to him, it is dangerous to lose faith in the old Gods, unless we can substitute some more rational form of religion as an outlet for those deeper emotions which lie within the lowest levels of the human mind, the absolute subconscious. Only as we replace our old superstitions with higher and better ideals to which we can give our passionate devotion can we retain a sane and normal attitude toward ourselves and toward life. There have been formulated for this purpose, two kinds of religion: first, the religion of humanity, which allows us to lavish all our love and tender emotions upon our fellow-beings; and second, the cosmic emotion which G. Stanley Hall has summarized as follows:

"God is simply the personification of the cosmic order, and religion is loyalty to it . . . 'Our Father' is merely an expression of my filial relation to the great one and all from which my own being was derived through the long processes of evolution. I am a son of the sky and the nebulae; thence I came and into them I shall be resolved. . . . This conception makes us realize that we are relatives not only of plant and animal life, but of rocks, soil, sea, air; brothers of every element; that all are our kin, for we have the same parent,—the primordial basis out of which the world arose. . . . It is this sanifying sense of being truly at home in the cosmos on which all religions rest." (9: pp. 139-140.)

Why Comte should choose the humanitarian religion instead of the cosmic interpretation which seems so eminently adapted to his type of mind, is one of the questions which this paper attempts to answer.

In the light of Jung's theory of the two opposing psychic tendencies of thought and feeling, Comte's history becomes significant. For the greater part of his life, he was preëminently the introvert type, reacting intellectually rather than emotionally to most situations, and actuated always by the egoistic lust for power. Even in childhood, he had developed that tendency to immure himself in scholastic

seclusion which became so prominent a part of his later development, while his rebellious student days were but the expression of the desire to show himself superior to all about him, even the wisest of his teachers, whom even at ten he criticised severely. At the age of twenty, he writes that in emulation of Benjamin Franklin, for whom he had a great admiration, he has "formulated the design to become perfectly wise," but adds that he has dared to conceive this ideal much earlier in life than did his idol. This naïve addition to his assertion shows once more his determination never to permit himself any feeling of inferiority to others in the realm of intellectual life. Herein, Comte furnishes us with a beautiful illustration of the Adlerian principle of compensation. (1:pp. 1-34.) Robinet, his most sympathetic biographer, has pictured him as the typical example of the neurotic constitution, physically undeveloped, and disturbed by continued ailments of the alimentary organs. (16:pp. 307-315.) For this organic inferiority, he compensated by a continual striving for intellectual superiority, sacrificing to his intellect all the natural play of youth, all the emotional tang which makes life a vivid and joyous reality. This struggle for a feeling of psychic power continued during the more mature years of his life. It was manifested in his refusals to admit that his once beloved teacher, Saint-Simon, had made any faint contribution to the Positive Philosophy, and it appeared in his intolerant attitude toward his wife. Schoff, in "A Neglected Chapter in the Life of Comte," tells us that he went so far as to sign himself Brutus Bonaparte in his marriage ceremony, and that he compared himself with St. Paul and Aristotle. (17.) Finally, his extrovertive tendencies found complete expression in the work which has made his name famous—the Positive Philosophy—and which may be briefly outlined as follows (12):

> Each branch of our knowledge passes successively through three different theoretical stages:
>
> 1. The theological or fictitious.
> 2. The metaphysical or abstract.
> 3. The scientific or positive.
>
> The first is the necessary point of departure of the human understanding, and the third is its fixed or definitive stage. The second is merely a state of transition. In the theological state, the human mind, seeking the essential nature of beings, the first and final causes, the origin and purpose of all things,—in short, absolute knowledge,—supposes all phenomena to be produced by the immediate action of supernatural beings. In the metaphysical state, which is only a modification of the first, the mind supposes, instead of supernatural beings, abstract forces, veritable entities, personified abstractions,

inherent in all beings, and capable of producing all phenomena. In the final, the positive state, the mind has given over the vain search for Absolute notions, the origin and destination of the universe, and the causes of phenomena, and applies itself to the study of their laws,—that is, their invariable relations of succession and resemblances. Reasoning and observation, duly combined, are the means to this knowledge. What is now understood when we speak of an explanation of facts is simply the establishment of a connection between single phenomena and some general facts.

There is no science which, having attained the positive stage, does not bear marks of having passed through the others. Some time since it was composed of metaphysical abstractions; and farther back, it took its form from theological conceptions. The different branches of our knowledge have passed through the three stages of progress at different rates, and have not therefore arrived at the same stage simultaneously.

The Positive Philosophy possesses four distinct advantages over other methods. First, the study of the Positive Philosophy affords the only rational means of exhibiting the logical laws of the human mind which have hitherto been sought by unsuitable methods. The second effect will be a regeneration of education. In the third place, it will advance the sciences by combining them. Last of all, the Positive Philosophy offers the only sound basis for that social reorganisation which must succeed the critical condition in which the most civilized nations are now living.

The principle on which we may base our classification of the sciences is found by comparison. All observable phenomena may be included within a very few categories, or sciences, so arranged that the study of each category may be grounded on the principal laws of the preceding, and serve as the basis of the next ensuing. The order of arrangement is determined by the degree of simplicity or generality of the phenomena included in each category. We must begin with the study of the most general or simple phenomena, going on to the more particular or complex, for this order fixes the degree of facility in the study of these phenomena, and is the logical connection of the sciences as determined by their successive dependence on each other. The order which results is this: Mathematics, Astronomy, Physics, Chemistry, Physiology and Social Physics or Sociology.

Mathematics has for its object the indirect measurement of magnitudes, and it proposes to determine magnitudes by each other, according to the prime relations which exist between them. The spirit of mathematics, therefore, consists in regarding as mutually connected all the qualities which can be presented by any phenomenon whatsoever. Evidently, all phenomena may be regarded as affording such considerations, and hence results the indefinite extent, the universality and simplicity of its phenomena, which places mathematics first in the hierarchy of sciences. The three branches of the mathematical science are calculus, geometry and rational mechanics. Calculus, which consists of arithmetic and algebra, deals with the most simple and general phenomena, and the truths which it formulates holds for all things. Geometry presupposes a knowledge of calculus, while rational mechanics depends on both the others.

Astronomy logically follows mathematics, for its truths rest on arithmetical, geometrical and mechanical laws upon which it exercises no influence, but to which it adds a group of new facts. Physics depends not only on the mathematical sciences, but also on astronomy,

for terrestrial phenomena are influenced by the motion of the earth and of celestial bodies. It consists of a study of the laws which regulate the general properties of bodies, always placed in circumstances which admit of their molecules remaining unaltered. Chemistry studies the modifications that all substances may undergo in virtue of their molecular reactions, and is thus a step in advance of physics. Biology, which consists of anatomy and physiology, gives its attention to the structure and activities of an organism, calling into use when necessary the truths established by physics and chemistry. Its peculiar office is the experimental and rational study of the phenomena of interior sensibility peculiar to the cerebral ganglions.

The social science is still confused by the theological and metaphysical points of view, so that our first task is to apply the positive methods here as in the other sciences, and ascertain the chief bases on which it is founded. The first division of this category is social statics, which inquires into the conditions which constitute social equilibrium and insure the permanence of social states. The individual life, ruled by personal instincts, prepares for personal morality; the domestic life, governed by the sympathetic instincts, subordinates the selfish tendencies to sympathy; while the social life has for its guides the development of the intellect and enlightened reason. Social dynamics considers society as a series of stages, each resulting from the preceding and leading on to the next by imperceptible gradations. Broadly speaking, this progress has been from the militaristic phase through the juristic phase to the industrial phase,—three stages of social development which correspond to the theological, metaphysical and positive stages of scientific progress. The positive viewpoint will modify human existence by a reconstruction of the scientific, political, moral and esthetic life, for all activities will be based on clear knowledge of what has gone before and an increasing prevision of results.

In all probability, we could obtain no better idea of Comte's nature during the first part of his life than by this glimpse of the contents of his consciousness as revealed in his Positive Philosophy. His is indeed the extreme introvertive reaction; he has cast aside forever theology and metaphysics, and has set up the intellect as the supreme good of existence. The emotions, too, in so far as is possible, must be gotten rid of, for they are a detriment to clear thinking. He bars psychology from his hierarchy of sciences because we can neither reason about those organs with which we do our reasoning, nor observe them, while the emotions so confuse our faculties that we can come to no valuable conclusion concerning them.

But one of the queerest turns taken by Comte's tendency to introversion appeared in his system of "cerebral hygiene." Long before the completion of his first great treatise, he had adopted the rule to abstain from the reading of all newspapers, periodicals, scientific publications, and indeed of all literature except the works of Dante and one or two other favorite poets, lest he be distracted by worthless ideas. John

Stuart Mill characterizes the outcome of this mental hygiene as "a gigantic self-confidence, not to say self-conceit," and adds that "as his thoughts grew more extravagant, his self-confidence grew more outrageous." (13:pp. 127-130.) In reality, not only was Comte's egoism strengthened by this procedure, to which it had in the first place given rise, but his "cerebral hygiene" itself was result as well as cause of his colossal self-esteem.

Comte's introvertive tendencies served his purpose very well for nearly thirty years, but he could not hope to escape forever the penalty which he was doomed to pay for having so long suppressed his affective life, both personal and absolute. It is not surprising that the next fifteen years of his life were a period of conflict between these two psychic forces, in which his repressed emotions struggled to find some outlet, causing the mental crises which so puzzled his followers. Until his marriage with Carolin Massin, Comte had met every situation with thought, but this was a condition which necessitated an emotional reaction, so he promptly developed the psychoneurosis which Jung asserts to be the only refuge of the introvert in such a crisis.

As we shall see later, Comte had a well developed mother complex. Perhaps this was reinforced by the fact that he had been under the maternal care only eight years, so that the mother of his childhood memories was the mother of that early period of the child's existence when she is for him all that is tender and loving, before she has had time to become identified with any of the thwarting factors of his environment. There could be no greater contrast to such a maternal type than Comte's wife. His mother had been a delicate, refined gentlewoman, sheltered in her holy Catholic faith. Carolin Massin was a hustling, energetic, business woman, who possessed an intimate knowledge of men and of life in all its varied phases. Comte had found her quite capable of satisfying his physical desires, but when he attempted to realize in her his ideal of the wife and mother, his whole subconscious soul rose in revolt, and he slipped into the neurosis previously mentioned.

Other factors doubtless contributed to bring about his first nervous breakdown. There can be little doubt that it tended toward the manic-depressive type, for it was expressed in fits of mania alternating with suicidal impulses. Moreover, Comte's physical weaknesses were of the kind that are characteristic of manic-depressive insanity, for he suffered constantly from disturbances of the alimentary tract. It is

significant, by the way, in connection with our definition of religion as a necessary psychic function, that during the two years of his mental aberration, Comte slipped back from his Positivist beliefs into the theological state of his early youth. In the final analysis, however, we cannot but conclude that the unconscious motive of this psychosis was an attempt to force his wife to conform to the maternal ideal which governed his affective life, for its onset followed her desertion of him for another man, and his recovery was promoted by her return and faithful care.

Comte's second mental crisis in 1838, though very slight, confirms this viewpoint, for it, too, coincided with threats of desertion by his wife, and was allayed by her postponement of her decision. That it was due to an outbreak of repressed extrovertive tendencies, is shown by Comte's own discussion of it:

"Its principal marked result consisted in a vivid and permanent stimulation of my taste for the different fine arts, especially poetry and music, which then received a considerable increase. You feel immediately the spontaneous affinity with my later tendency towards a life principally affective; and further, it very happily improved my work in all relating to the esthetic evolution of humanity." (15.)

Finally, in 1845, came the great emotional crisis of Comte's life, when, under the influence of his love for Clotilde de Vaux, the affective element assumed gigantic proportions, and his introvertive tendencies swung over wholly and irrevocably to the ambi-valent impulses of extroversion. No better proofs of the remarkable influence which Clotilde exercised upon his destiny can be found than in a comparison of his second great work, the *"Système de Politique Positive,"* with his first treatise on Positive Philosophy. There could be no more striking evidence of the radical change in Comte's nature than his reiteration, in this second work, of the fundamental necessity of the affective life and of religion, and his utter repudiation of his former coldly scientific viewpoint.

The Positive Polity is dedicated in the most fervent terms, "To the sacred memory of my eternal friend, Mme. Clotilde de Vaux," and this dedication is ended with a quotation from Dante, which applies to Clotilde the impassioned and reverent apostrophe which the poet addressed to Beatrice. The appendix to the first volume contains Mme. de Vaux's novelette, *Lucie*, which is nothing more nor less than a picture of her own life, little to be recommended from a literary viewpoint, though Comte classed it with the works of George Sand. It

also contains her poem, *Thoughts of a Flower,* which Comte valued so highly and rated so absurdly.

The Positive Polity proper is published in four volumes, and its scope may be stated as follows. (5.)

Volume I is entitled *A General View of Positivism,* and is a summary of Comte's Positive Philosophy and religion of humanity, and a statement of his plan of social reconstruction of which Love is the principle, Order the basis, and Progress the end. The Positivism of this writing is, however, a different Positivism from that explained in his earlier works, for it recognizes that the intellect must ever be subordinated to the affective life. The new Positivism means a control of the selfish affections and a strengthening of the unselfish motives. While it makes the emotions the highest force in life, it will satisfy the reason by making Sociology still the supreme science and humanity our God. It will make use of its knowledge of the laws of social relativity to aid human progress, and it will set up a priesthood to teach the subordination of selfish love to social love.

This is a most auspicious time to introduce Positivism, for the French Revolution has stimulated the desire for progress and hence will lead to a study of social phenomena. Under the influence of the Revolution too, a sense of human development and the social feelings has arisen in the minds of people on the lower classes, not only in France but in all Western Europe. The great problem of reconstruction is the subordination of politics to morals, and it will be worked out in a republic composed of Italy, Spain, England and Germany grouped around France as the center.

Spiritual organization is the only point where an immediate beginning can be made, and when this has progressed sufficiently it will regenerate political institutions. We must have a priesthood to educate the social emotions which are the basis of morality.

The domestic relations form the bridge between selfish love and universal benevolence. Woman as wife and mother has a great mission, for the worship of woman is a preparation for the worship of humanity. The Positivism which is based only on science and the intellect is incomplete. Complete Positivism gives play to the emotions in poetry, art and religion. The religion of humanity is the rational culmination of Positivism, the great conception toward which every aspect of that philosophy converges. We must therefore institute a calendar in commemoration of those who have served Humanity, and hold festivals in worship of this Great Being.

Science and art cooperate in the service of this religion. The history of universal Love, the soul by which the Great Being Humanity is animated, is in itself an endless theme for the poetry of the future, while artists can devote their noblest works to a representation of the emblem of the Great Being, a woman of thirty with her son in her arms. The sciences all lead to the supreme science of Sociology, and hence can be used in the service of Humanity.

Here, only, does Comte digress from his theme of love and religion long enough to give a brief review of his hierarchy of sciences as elaborated in his *Cours de Philosophie Positive.*

The second volume of Positive Polity is called *Social Statics.* It, too, stresses the necessity of religion in words which seem to be drawn from Comte's own experience, for he declares that no mere scientific knowledge can bring to us inner harmony, but that unity of man within can arise only by submission to an Order without; that we

must find an emotional outlet in a Being like but superior to man. This introduction is followed by an historical sketch of religion, a survey of the family and other social institutions, and by a revised hierarchy of sciences in which there is placed above the science of Sociology a new science of Morals, which it is the duty of the priesthood to teach.

In the interval between the publication of this volume and the following one, Comte wrote *The Catechism of the Positive Religion,* a popular exposition of the religion of humanity which he was treating more adequately in his Positive Polity, and which contained, among other data, his Positivist Calendar with its months and days consecrated to the memory of those who had benefited humanity by their lives and deeds. The name of Clotilde de Vaux was prominent among the saints listed on this calendar.

Volume III, *Social Dynamics,* is an account of man's evolution from a less religious to a more religious state. The human mind has had three chief stages of development. The first of these is the physical, which is more general but less complex and less noble than the other two. The second is the intellectual, which is more complex and noble than the first, but less so than the third. The third is the moral stage, which is less general, but more complex and noble than either of the others. Thus, while retaining his old idea of social development through the militaristic, juristic and industrial stages; he casts aside his former theory of the three stages of human knowledge,—the theological, metaphysical and scientific. The major part of the third volume is devoted to an evaluation of the contributions to social progress made by the social organizations of the past through their religious forms and ceremonies.

The fourth and last volume of the Positive Polity is "The Synthetical Presentation of the Future of Man," and involves a presentation of the religion of humanity in all its details, as well as the scheme for its introduction as the world religion. The Great Being Humanity is defined as "the whole constituted by the beings past, present and future, which co-operate willingly in perfecting the order of the world." It is, therefore, represented by the dead, who collectively represent humanity. Fetichism is brought into its service because fetichism in inculcating a love for external objects, paves the way for enhancing the altruistic emotions, and thus develops love of humanity. Immortality is subjective, and means incorporation in the Great Being Humanity, and a living on thus in the memory of succeeding generations. There are two methods of worship in this religion: one, the worship of Humanity itself; the other, adoration of its personification in woman as wife and mother.

In place of the confirmation rites of Catholicism, the priesthood of humanity will administer to each person nine sacraments. The first of these is known as presentation, and takes place at birth. The priests accept the newborn child presented by the parents, and promise to prepare it for the service of the Goddess of Humanity. The second is initiation, and is the transference of the fourteen year old child from the maternal care to the systematic training of the priesthood. The third is admission and is the authorization of the twenty-one year old youth or maid to serve humanity. Destination, the fourth

sacrament, is administered at the age of twenty-eight, and is the consecration of the man to his life work. In the case of woman, this sacrament is combined with the fifth sacrament of marriage, for woman has no other destination. The sixth sacrament, maturity, which takes place at forty-two, impresses upon man the stern responsibility of service to humanity. Twenty-one years later comes the seventh sacrament, which is called retirement, and which limits personal influence to counsel and advice. The eighth sacrament of transformation replaces the old Catholic death bed ceremony, and consists of a just summing up of a man's life and his commitment to the other world. Seven years after death is the ninth and last sacrament of incorporation, which is the final decision of the priesthood as to whether the dead person is to be incorporated in the Great Being Humanity, or consigned to oblivion.

The other distinguishing features of the religion of humanity and the Positivist regime, are the supreme power of the priesthood, the calendar previously mentioned in connection with the Positivist Catechism, and the annihilation of all books except the 150 volumes (mostly poetry) which Comte deemed worthy of preservation in his Positivist Library.

It is the extreme contradiction between Comte's positions in his two great works that his biographers have tried to reconcile, and psychologists have attempted to explain. Amid these diverse opinions, there is at least one point of agreement,—that his relations with Clotilde de Vaux were the turning point in his career. Theirs was indeed a strange companionship. Mme. de Vaux was born of a highly respectable family, and possessed a delicate, spirituelle beauty combined with native intelligence and rare charm of personality. Shortly after her marriage, her husband had been convicted of capital crime and sentenced for life to the galleys, so that she was living in the same moral freedom and personal isolation as Comte himself. The sympathy which the similarity of their positions enabled them to feel so poignantly for each other soon grew into a deeper attachment, but though their meetings were frequent and they exchanged daily letters which breathed the tenderest devotion, their love never found any fuller expression. It was only a year after their first meeting that Clotilde died, but her memory could never expire in Comte's mind. (5.) "When Beatrice died, Dante's grief filled her room up with something fairer than the reality had ever been. There is no idealizer like unavailing regret, all the more if it be a regret of fancy as much as of real feeling. She early began to undergo that change into something rich and strange in the sea of his mind which so completely supernaturalized her at the last." (Lowell: *Among My Books, Vol. II: Dante.*) Even so, Clotilde became for Comte what his favorite heroine, Beatrice, had been to Dante.

"Dear angel," he says, after her death, "I can only adore you by trying to serve better the Great Being in whom I know you are irrevocably incorporated."

But this worship for Mme. de Vaux passed all bounds of rationality and became fetichistic in its import. The arm chair in which she was wont to sit became his altar where three times daily he prayed to her divine memory; he made weekly pilgrimages to her tomb even as the palmers of old sought the holy sepulchre; a flower she had worn, her "sacred letters," became so impregnated with the thought of her as to suggest her presence; her illiterate servant girl, Sophie Bliot, became idealized in Comte's eyes because she had served her mistress so faithfully, and finally, he repeated every morning of the nine years during which he survived her death the following poem written by Mme. de Vaux, which he characterizes as "graceful verses, whose sweetness might well have been envied by Petrarch." (4.)

THE THOUGHTS OF A FLOWER

O ! thanks my good fate! to be loved I am born!
Let mortals still rail against thee in their might,
Let pride to the foot of thy altars invite,
I have my perfumes and my morn.

I have the first glance of the sovereign of day,
His fiery kiss, his splendid array;
A sisterly smile young Aurora bestows;
I have the fresh breeze, and the flavor that flows
From the dewdrop that rests on my chalice's brim;
I've the sunbeam that sports on the precipice's rim,
I've the magical picture, the unrivalled display,
Of the universe opening the portals of day.

The coldness of mortals my life cannot blight;
So sweetly I sleep on the breast of delight;
Protected by nature, whose wealth I ne'er miss,
Transported I wake to her banquet of bliss.

To beauty a charm I have often supplied,
On a pure heart my pure light shines,
Pleasure in garlands me entwines,
And happiness fastens me to its side.

When the nightingale rides
On my stem in its play,
That its song may have sway,
All nature subsides,
Its secrets love whispers to me,
Positions so sweet I defend,
My aid in its mysteries lend,
Of all modest hearts I'm the key.

O, sweet fate, if unholy sighs
Had power the course of thy laws to move,
Alone here below, in my transparent guise,
I would bud at the breath of love.

To storms that defile,
Surrender me never,
May the flowers ever
At love's festivals smile.

It is no wonder that Comte's religion of Humanity set forth in his Positive Polity has been considered simply his commemorative worship of Clotilde de Vaux extended to a universal scale. Dumas considers it a revival of his early training in the rites of Catholicism, in which he substituted Mme. de Vaux for the Virgin Mary, and transformed his human love into a mystic form. (7: pp. 193-246.)

"His was a love always sensual, and Clotilde, while exciting it to the utmost, repressed it. He became voluntarily chaste after knowing her. Comte's religion had an inspiring motif and an universal one, but his love for Clotilde transformed it . . . . Finally, the glorification of woman is the glorification of Clotilde, and the social rôle which he attributes to them is the rôle which she played in his own life." (7: pp. 198-210.)

This interpretation of the rôle Clotilde played in Comte's life and in the development of his Positivist Religion is fundamentally correct, but Dumas misses a connection finer and more subtle than that of mere repression and sublimation of the sex instinct in its simple form. Clotilde drew Comte's affections irresistibly to herself not through sympathy or mere physical attraction, but because she was the realization of his mother ideal. His mother had been a noble woman, enshrined in her holy Catholic faith. Clotilde was similarly pure and true in thought and act. Just as his Oedipus complex had prevented him from feeling any real love for his wife, although she satisfied his sensual nature, so it bound him irrevocably to the woman who never yielded to his passionate desires. Comte himself had some dim intimation of this mother identification, for he writes in the preface of his Positive Polity:

"A noble and tender mother, whom I lost fourteen years ago, was the first real source of all my essential qualities, not merely of emotions, but also of practical and even of intellectual capacities. Nevertheless, I have now humbly to confess that I never felt for her that love which her worth and her sorrows claimed; and that even what love I felt was never

sufficiently shown, owing to the false shame of seeming too fond which is stimulated by modern training. But the worship of my Clotilde has at last aroused in me veneration for my honored mother. Her image and that of Rosalie Boyer are more and more intimately mingled, both in my weekly visits to the cherished tomb and in my daily prayers." (5:p. xviii.)

It is in this Oedipus complex, also, that we find the key to Comte's religious conception. Had he been wholly the introvert, his deeper subconscious life would have found its expression in the type of religion common to so many other philosophers,—the cosmic interpretation mentioned earlier in this paper. But in his case, the long repressed mother love shaped his unconscious projection in religion. Everywhere, woman—the maternal type—is the supreme ideal. The symbol of the *Grand Être* Humanity is a woman of thirty with her son in her arms. (Clotilde had died at the age of thirty-two). Likewise, the *Grand Fétiche* is mother earth. And the qualities which Comte would have every human being cultivate and make the guiding principle of his life are the mother qualities,—sympathy, unselfish love and tender helpfulness.

It is true that in its worship of the madonna Comte's religion of humanity resembled the Catholic faith. Moreover, the supreme power of the priesthood to judge both the living and the dead; the Positivist Calendar with its religious festivals and commemorative worship of the sainted dead who have best served society; the nine social sacraments which replace the old rites of baptism, confirmation and death bed confession; the incorporation of fetichism which is so strongly suggestive of relic worship;—all these are reminiscent of Catholicism. Yet these parallelisms account only for the form which Comte's religious enthusiasm assumed; they do not explain its ultimate origin. The deeper source, as has been intimated, is the necessity of objectifying those lower levels of the subconscious formed by phyletic experience, and furnishing an outlet for long repressed infantile desires.

In the final analysis, it is safe to conclude that Comte was essentially the introvert, but three times during his career, his unconscious emotional life came to the surface, resulting each time in a conflict that led to a mental derangement which lasted until his intellectual faculties could resume their interrupted sway. In his third and last crisis, which occurred just after he had fallen in love with Clotilde de Vaux, there were several complicating factors which reinforced his extrovertive functions. As a result, the latter remained in power, and found expression in his exaggeration of the affective element

as the supreme good of all existence, and in his religious doctrines. It may be that his system of commemorative worship was doubly motivated, and that it not only gave him an opportunity of expressing his love for Clotilde, but that it also gave him assurance that he, too, would be honored in death as he never had been in life. This once supreme will to power made one other attempt to assert itself, resulting in Comte's attempt to place himself in the office of the High Priest of Humanity;—if he can no longer be the supreme intellectual being, he will at least become the highest moralist, the great religious pontiff of the whole world.

It is time to recapitulate the interacting conditions which united to reinforce the last great outbreak of Comte's affective life. In the first place, Robinet assures us that he had that mental diathesis, that innate instability of the nervous system, which predisposes its possessor to the neurotic conflict. (16:pp. 307-315.) During adolescence, which is normally a period of intense emotional sublimation, of imaginative day-dreams and heroic idealizations, Comte had sternly repressed all these natural tendencies, making reason his one ideal. The period just previous to senescence with its entire loss of passion, is in a sense a repetition of adolescence, for it is conditioned by a resurgent outburst of affectivity and a corresponding lack of control. It is a phylogenetic regression, in which old feelings and the beliefs grounded in them rise again, and dominate thought, and will not submit to its rule. (18: pp. 180-181.)

It was at this critical period of his life, when he was just forty-seven years of age, that Comte met Clotilde de Vaux. Shaken to the depths of his being already by the emotional disturbances due to his age and reinforced by the physical repressions of his youth and early manhood, Comte now attempted to impose upon himself the additional burden of physical repression, that he might be worthy of the affection of the woman who was for him the embodiment of all purity and goodness, the personification of his unconscious mother ideal. Whether Clotilde also awakened that phyletic image imbedded within his deeper subconscious life—the sexual ideal formed by his racial memories—we can only speculate, though the deeply religious feeling which he now felt for the first time would seem to indicate that such was the fact. It is quite possible, however, that this is sufficiently explained by his long repression of the deeper subconscious life which ordinarily finds expression through the medium of religion, and its consequent increase in energy.

This we know,—that Comte's pent-up emotional life would no longer be denied, but rushed forth in a mighty torrent, sweeping all before it, projecting itself upon all objects of the external world upon the slightest pretext, and creating for itself new outlets in a world made half of phantasies. And so he seized upon religion, which has always been the supreme emotional outlet of the human race, creating for himself and for mankind, a faith expressed largely in the terms of the old Catholic belief of his infancy, and affording the highest gratification of his human love. As the affective forces of his life grew stronger and stronger, he came to have that hatred of the intellectual and of scientific research which so puzzled his followers, until at last he planned a general holocaust of all books except the few which he deemed worthy of preservation in the Positivist library. Thus he ended his brilliant career in a storm of emotion which never allowed him to make proper adjustments to life because his adaptive functions had so long been governed entirely by thought.

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ON "RETIRING" AND "ADVANCING" COLORS

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Doubtless it has often been noted that various colors in the same plane do not appear to be in the same plane. The artist speaks of retiring and advancing colors; and some painters who are fortunate in being acquainted with the scientific facts of color have utilized this phenomenon in attempts to create the illusion of the third dimension in paintings. The phenomenon is quite strikingly apparent to the author when viewing the projected image of a lantern slide on which there are words in various colors as is commonly the case with slides used for advertising purposes. Never having seen any quantitative data on the subject, it appeared of interest to ascertain the magnitude of the effect and whether or not the impression was generally the same for all observers. The work is by no means complete and may cover ground that has already been covered but a search has not yielded any information that would indicate this. This work has been reported in abstract[1] under the title of "stereoscopic" colors. It appears that this describes the phenomenon and its practical uses quite satisfactorily.

The apparatus consisted of two wooden boxes, each containing a tungsten lamp and each equipped in front with an aperture covered with opal glass. Before the diffusing glass in one box were placed a red filter (fairly high purity) and an opaque card in which a plain letter X was cut. The other box was similarly equipped with a blue filter (fair purity with no red transmission) and a diaphragm on which a plain letter E was cut. The height of the letters was 2.2 cm. and the width was 1.5 cm. The boxes, which were painted white inside and black outside, were arranged on tracks side by side so that they could be moved independently to and fro by the observer by means of strings and pulleys. In a darkroom these two colored letters stood out in space; and, while one was kept in a fixed position, it was possible for the observer to move the other to and fro until the two appeared

[1] *Jour. Frank. Inst.* 183, 1917, p. 773.

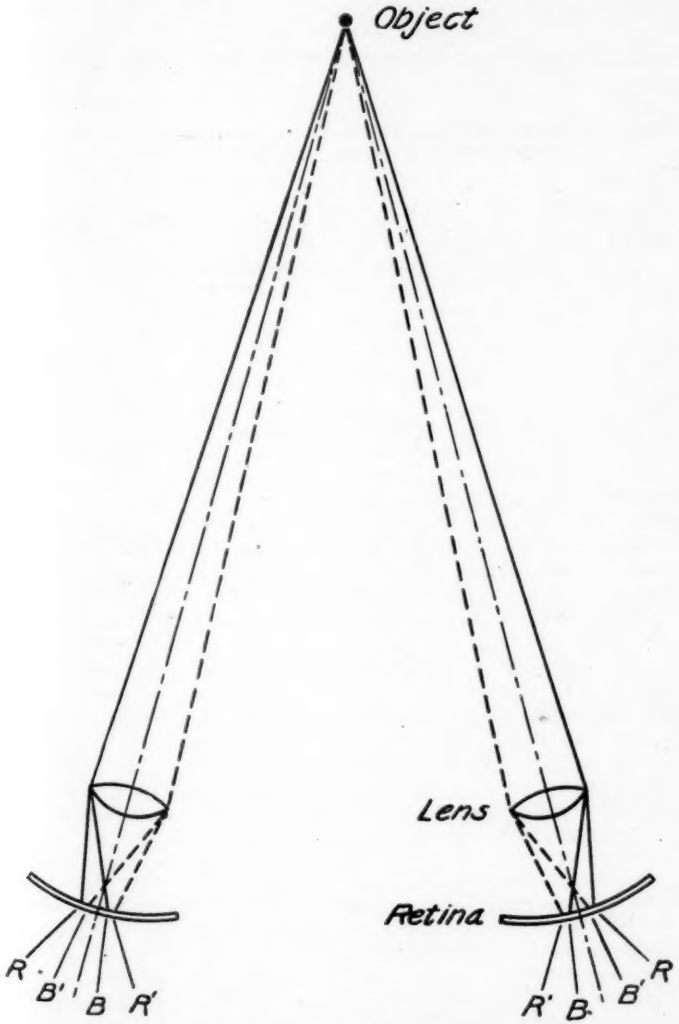

FIG. 1.—Illustrating a possible explanation of 'stereoscopic' colors.

in the same plane. In obtaining the data given in the table, the red X was moved. The observer was seated at various stations from 2.5 to 7.25 meters from the fixed blue E. At each station at least ten independent settings were made in a series. None of the observers, with the exception of *M. L.*, were acquainted with the phenomenon under consideration.

In the table, data are presented for nine observers. At the top of each column is shown the distance in meters of the observer's eyes from the blue E; and the figures in the columns indicate the distance in centimeters which the red X was moved behind (+) or in front of (—) the blue E in order that the two would appear in the same plane.

Total distance in metres	2.5	4	5	6	7.25
	cm.	*cm.*	*cm.*	*cm.*	*cm.*
M. L.	2.8	16.0	24.6	39.8	57.7
H. K.	4.8	13.7	21.0	31.7	46.2
F. G.	1.6	5.3	7.6	5.3	12.5
P. H.	3.1	15.1	8.4	35.6	49.5
L. M.	2.6	4.5	13.4	14.4	18.3
E. K.	7.4	28.2	50.9	22.6	71.7
H. P.	5.1	2.4		23.2	17.4
L. C.	—0.4	—1.9	1.4	8.9	—2.7
G. H.	—7.4	—18.5	—34.0	—37.6	—49.7

It is seen that in most cases it was necessary to move the red X farther away than the blue E in order to make both appear in the same vertical plane perpendicular to the line of sight; and that this distance generally increased with the distance of the observer's eyes. It is quite possible that through training the results for a given observer would become more consistent but even the degree of consistency indicated in the data obtained from observers, who until after the experiments were not acquainted with the phenomenon, appears quite striking. The phenomenon is somewhat fluctuating but the results for a given observer usually indicate a definite trend. Computations from the data by *M. L.* indicate that chromatic aberration in the eye could account for the effect but the negative values for the last two observers and other considerations complicate this explanation.

Observer *M. L.* performed the following experiments, the results of which were confirmed by other "positive" observers who were used. If the two letters were placed in the same plane they did not appear in the same plane but, by nearly closing the eyelids, they appeared to move into the same plane. Similarly when the two objects were placed so that they *appeared* in the same plane, on nearly closing the eyelids, the

red X appeared to move into its true position; that is, back of the blue E. When two very small artificial pupils were placed respectively before each eye the blue E could be made to appear either behind or before the red X by moving the pupils farther apart or nearer together. It appeared that, for those who normally saw the red X in front of the blue E, when the small artificial pupils were moved closer together the blue E apparently moved forward very strikingly; when the pupils were separated a trifle more the blue E moved backward. Through these small artificial pupils both images appeared simultaneously in focus at all times, which of course was not true with the natural pupils. On turning the head slightly, results similar to the preceding were obtained. Differences in relative brightness and shape of the colored characters seemed to influence the magnitude of the results somewhat but the effect was never reversed. The effect could not be observed with certainty with one eye.

In order to give an idea of the consistency of the individual settings the mean variation from the mean was computed for a number of cases. In general this was higher for the inexperienced observers but from *M. L.* it was 0.39 cm. (14 per cent.) at the 2.5 meter distance. It decreased with the distance of the observing station and was 1.27 cm. (2.7 per cent.) at the 7.25 meter station. This indicates that the phenomenon was very definite.

A complete explanation can hardly be justified on the basis of the present data but owing to an indefinite interruption of the work an hypothesis will be briefly presented. It appears possible that the different refractive indices of the eye media for radiant energy may play a part in causing this effect. These may account for a displacement of the colored images which gives rise to the "stereoscopic" effect quite in the same manner as in ordinary vision. The point may be brought out more clearly by means of Fig. 1. Assume that only the temporal portions of the eye lenses are used; then if the object is blue, the images will be found at B (solid lines) and if the object is red, the images will fall at R. Naturally the blue object will seem to be farther away than a red object in the same position since these respective positions of the images generally correspond to far and near objects. If the nasal portions of the lenses are considered the dashed lines may be referred to, the blue and red images falling at B′ and R′ and the reverse effect is obtained. In this case the effect will be reversed thus accounting for the results obtained by moving the small artificial pupils further apart or nearer to-

gether as already discussed. The figure is only diagrammatic and does not pretend to illustrate the entire condition accurately. If such an explanation is correct or even partially correct the differences between the results obtained by the observers will likely be explained partly by differences in the shapes and relations of the various parts of the eyes such as curvatures, eccentricity of pupils, refractive indices, etc.

It is shown by these data that colors do actually 'retire' and 'advance'; and that in general blue is retiring and red is advancing. If the explanation which has been suggested is correct the arrangement of hues in the spectrum is a true index. Although employing impure colors the testimony of the artist supports this conclusion. This explanation appears quite satisfactory, however, the author does not wish to emphasize it too much at the present time. Unfortunately the strikingly 'negative' observer, *G. H.*, is not available so that further inquiry with this definite exception of the group is not possible at present.

The author is indebted to Mr. H. H. Kirby for assistance in obtaining these data.

A NOTE ON ASSOCIATION-TIME AND FEELING

By Edward Chace Tolman and Isabelle Johnson, Northwestern University

The free association experiment has been widely used for the study of emotional complexes[1]. Long lists of the effects caused by such complexes have been compiled. These effects include peculiarities as to kind of association and as to association-time. It seems, however, that little attention has yet been directed to the effect of simple feelings as opposed to complexes.

The one work we have found which studies directly in normal subjects the effect of simple feeling upon association-time is Birnbaum's[2] He used pleasant, unpleasant, and indifferent words as stimuli, and presented them to each of five hospital attendants. The pleasant words, of which there were twenty, included 'health,' 'riches;' the twenty unpleasant words included 'death,' 'enemy,' and the like; and the twenty indifferent words were such as 'hand,' 'house,' 'hat.' His results were negative. The median times for the associations evoked by each of the three groups of words were almost exactly the same; and this was found to be true for each of the five subjects.

The method employed in our own experiments was similar. In our preliminary series there were twenty words of each kind; these were chosen without a definite principle of classification as to the nature of the feelings they were expected to evoke, but it was not supposed that they would arouse any fundamental complexes. They were selected from a long list of nouns and adjectives we happened to have on hand, as follows:

Pleasant: blossom, banquet, lively, castle, slender, peaches, clean, lovely, romance, starry, dinner, darling, Cupid, flower, kindness, lily, wedding, candy, generous, honest.

Unpleasant: pimples, filthy, blindness, bankrupt, poverty, sulky, snobbish, prisoner, sneering, haggard, brutal, burglar,

[1] See for a good resumé: Kohs, Samuel C. *Am. Jour. of Psychol.*, XXV, 1914. pp. 544-594.

[2] Birnbaum, Karl. *Monatsschr. f. Psychiat. u. Neurol*, XXXII, 1912, pp. 95-123, 194-220.

scowling, gloomy, drunkard, swindler, illness, cruel, selfish, ugly.

Indifferent: fibre, gravel, balance, cover, counter, kettle, measure, number, oven, sentence, ladder, squirrel, jackknife, basket, soap, reindeer, ribbon, knocker, evergreen, horse.

These sixty words were mixed in an irregular order, but so that not more than three of the same feeling-tone followed one another in immediate succession. The entire list was then presented with the usual instructions[3] for free associations to each of 17 women and 18 men. The subjects were divided between the two writers, both of whom acted as experimenters. The times were measured by a stop-watch.

The medians were computed for each of the three kinds of words; and the ratios were found for each subject of the 'pleasant' median to the 'indifferent' median $\left(\frac{P}{I}\right)$, and of the 'unpleasant' median to the 'indifferent' median $\left(\frac{U}{I}\right)$. The decision as to whether the pleasant or the indifferent words had the greater tendency to cause long association-times will depend upon the distribution of the subjects in regard to the ratio $\frac{P}{I}$. If this tends to exceed 1, then the pleasant words tend to cause longer association-times; if the opposite, the indifferent words tend to cause the longer times. Similarly the decision as to the unpleasant and the indifferent words will depend upon the distribution of the subjects with regard to the ratio $\frac{U}{I}$. In examining these distributions, however, it is obvious that a value of $\frac{U}{I}$ or $\frac{P}{I}$ equal, for example, to 1.5 $\left(\frac{3}{2}\right)$ would be balanced by one equal to 0.666 $\left(\frac{2}{3}\right)$ and not by one equal to 0.5; while a ratio of 0.5 $\left(\frac{1}{2}\right)$ would be balanced by one of 2.0; and so on. Now the logarithm of 0.666 is equal and opposite in sign to the logarithm of 1.5; similarly the logarithm of 0.5 is equal and opposite to the logarithm of 2.0, and so on. Therefore in plotting the distributions we have used the logarithms rather than the direct ratios themselves.

[3] Whipple, G. M. *Manual of Mental and Physical Tests,* Part II. p. 55.

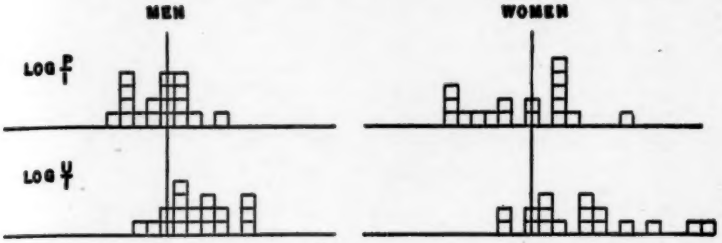

FIG. 1

Figure 1 presents these plots for the men and women separately. Each square represents an individual, and its distance to the right or to the left of the centre line represents the value, plus or minus, of the logarithm of the ratio for that individual. Thus squares to the right of the centre line mean individuals with ratios greater than 1, squares to the left of the centre line individuals with ratios less than 1.

Examining first the two $\frac{P}{I}$ plots, we see no clear tendency in either case for $\frac{P}{I}$ to be more often either greater or less than 1. Turning, on the other hand, to the $\frac{U}{I}$ plots, we see a very decided tendency in both cases for $\frac{U}{I}$ to be greater than 1. Thus the pleasant words as stimuli were not noticeably different from the indifferent words; but the unpleasant words showed a decided tendency to cause longer association-times.

This result contradicts Birnbaum's negative finding. A question arises, however, as to whether the longer times obtained for the unpleasant stimulus-words may not have been due to true complexes rather than to mere simple unpleasantness. Words like bankrupt, snobbish, drunkard, etc., may have been connected with subjective emotional histories. In such a case the results would merely point to the already well-established fact that complexes as such tend to lengthen association-times. They would not answer our original question as to the effect of simple feelings upon association-times.

In order to examine with greater precision this original question, a more carefully selected list of words was used. The words were chosen as appealing to several distinct depths of

feeling. Thus of thirty pleasant and thirty unpleasant words used, ten in each group referred to simple sense qualities only, ten or more of the pleasant to success, and ten of the unpleasant to failure; while the last ten of each group referred to love and home on the one hand, and to death and objects of disgust on the other. If it should appear that the simple unpleasant sense qualities were just as provocative of lengthened association-times as the words dealing with complexes, such as failure, death, and disgusting objects, we should conclude that unpleasantness *as such* really lengthens association-times.

TABLE I

Pleasant	Unpleasant	Indifferent
Sense	*Sense*	*Sense*
smooth	rough	still
fragrant	dusty	round
sunny	overcast	crooked
sparkling	dull	high
silvery	dingy	narrow
sweet	sour	swinging
airy	stuffy	tall
clean	dirty	bent
juicy	bitter	twisted
soft	chilly	wide
Success	*Failure*	
victory	defeat	motion
success	failure	incident
triumph	remorse	group
genius	fool	people
career	shame	occupation
reward	disgrace	occasion
achievement	guilt	change
praise	blame	individual
skill	stupidity	action
applause	scorn	feeling
Love	*Death*	
courtship	grief	business
wedding	funeral	meeting
lover	corpse	stamps
kiss	coffin	student
bridesmaids	undertaker	writing
Family-Home	*Disgust*	
sister	snake	hill
mother	sweat	water
family	worms	woods
parents	sores	stones
home	swill	road

Before presenting our results we may mention several further improvements in method. In each group of words, pleasant, unpleasant, and indifferent, the same proportion of nouns and adjectives was used, as was not the case in the previous experiment. This was to allow for the fact discovered by Crane[4] that adjectives, as such, tend to cause shorter association-times than do nouns. Also the proportion of concrete and abstract terms was kept as nearly as possible the same for each group of words. Table I presents the three groups in parallel columns. Words supposed to be of equal difficulty appear in the same horizontal line.

In presenting the lists, the words were mixed in the following ways. The words in each sub-group, such as 'sense,' 'success,' 'love,' 'disgust,' were evenly distributed over the entire list. The words of the three different feeling-tones were irregularly mixed, but so that not more than three words of the same feeling-tone followed each other in immediate succession. For not more than two subjects, however, was the exact order of presentation the same.

In order to eliminate the personal equations of the experimenters, an electric starter and stopper was used for the stopwatch.[5] This was connected with a falling shutter exposure apparatus and a lip-key. The stimulus-words were presented

TABLE II

TOTALS

30 pleasant, 30 unpleasant, and 30 indifferent words

Men				Women			
Name	P	U	I	Name	P	U	I
A.....	.82	.81	.77	K.....	1.17	1.40	1.30
B.....	.99	1.26	1.15	L.....	1.47	1.60	1.54
C.....	1.07	1.23	1.13	M.....	1.01	1.08	1.03
D.....	.94	1.02	1.00	N.....	.81	1.04	.91
E.....	1.19	1.25	1.15	O.....	1.29	1.47	1.38
F.....	1.53	1.68	1.63	P.....	1.41	1.70	1.43
G.....	1.12	1.08	1.10	Q.....	.98	1.08	.90
H.....	1.53	1.63	1.56	R.....	1.53	1.54	1.50
I.....	1.15	1.20	1.08	S.....	1.10	1.67	1.08
J.....	1.70	1.48	1.55	T.....	.87	1.30	.95

[4] Crane, H. W. *Psychological Monographs*, XVIII, 1915, whole No. 80.

[5] In the previous experiment, the times obtained by one of the experimenters averaged considerably shorter than those obtained by the other. The size of these personal equations led to the suspicion that the positive results obtained might have been due in part to unconscious influences exerted by the experimenters themselves.

TABLE II—*Continued*

SENSE

10 pleasant, 10 unpleasant, and 10 indifferent words

Men				Women			
Name	P	U	I	Name	P	U	I
A.....	.90	.77	.60	K.....	1.07	1.17	1.30
B.....	.85	1.05	1.00	L.....	1.30	1.50	1.45
C.....	1.15	1.10	1.00	M.....	.99	1.05	1.03
D.....	1.00	.90	.80	N.....	.75	1.00	.94
E.....	1.00	1.30	1.03	O.....	1.26	1.40	1.25
F.....	1.40	1.33	1.40	P.....	1.26	1.40	1.30
G.....	1.17	1.05	1.02	Q.....	.83	.95	.60
H.....	1.43	1.60	1.55	R.....	1.58	1.26	1.50
I.....	.90	1.20	.99	S.....	1.03	1.23	.80
J.....	1.50	1.50	1.70	T.....	.75	1.10	.85

SUCCESS-FAILURE

10 pleasant, 10 unpleasant, and 10 indifferent words

Men				Women			
Name	P	U	I	Name	P	U	I
A.....	.83	.80	.87	K.....	1.35	1.40	1.33
B.....	1.05	1.35	1.25	L.....	1.65	1.63	1.70
C.....	1.10	1.40	1.50	M.....	1.10	1.06	1.06
D.....	1.05	1.20	1.33	N.....	.93	1.10	.85
E.....	1.15	1.30	1.14	O.....	1.40	1.65	1.54
F.....	2.10	1.90	1.77	P.....	1.50	1.75	1.43
G.....	1.18	1.07	1.03	Q.....	1.00	1.00	.94
H.....	1.75	1.60	1.80	R.....	1.30	1.80	1.77
I.....	1.40	1.53	1.18	S.....	1.45	1.85	1.55
J.....	1.83	1.50	1.90	T.....	1.55	1.30	1.03

LOVE, FAMILY—DEATH, DISGUST

10 pleasant, 10 unpleasant, and 10 indifferent words

Men				Women			
Name	P	U	I	Name	P	U	I
A.....	.75	.85	.90	K.....	1.00	1.57	1.37
B.....	1.00	1.30	1.17	L.....	1.30	1.60	1.57
C.....	.95	1.55	1.00	M.....	.90	1.17	1.00
D.....	.83	1.10	1.07	N.....	.80	1.05	.85
E.....	1.15	1.18	1.22	O.....	1.20	1.45	1.40
F.....	1.15	1.75	1.63	P.....	1.37	2.00	1.70
G.....	1.04	1.10	.98	Q.....	1.03	1.55	1.20
H.....	1.80	1.70	1.37	R.....	1.40	1.60	1.23
I.....	1.17	1.08	1.20	S.....	1.00	1.60	1.20
J.....	1.60	1.45	1.22	T.....	.82	1.54	.87

visually, and the subject in reacting with associated words used the lip-key. Several practice words were given before the main series.

The median times for the 10 men and the 10 women experimented upon are shown in Table II. The ratios for these times, plotted as in the preceding case, are shown in Figure II.

The plots at the top show the complete results when the medians were computed from the total 30 words of each feeling-tone. It is clear at once that these data substantiate the findings of the previous experiment. The $\frac{P}{I}$ results indicate no clear tendency for shorter or longer times for pleasant words than for indifferent words. The $\frac{U}{I}$ results, on the other hand, for both men and women, point very decidedly to longer times for the unpleasant words.

Turning now to the partial results, and first to those for the words referring to sense qualities, we note decided evidence of longer times for the unpleasant words than for the indifferent, but no evidence of either consistently longer or shorter times for pleasant words than for indifferent ones. This is important. It solves the main problem we set out to investigate, for it proves that *simple unpleasantness as such lengthens association-time.*

Turning to the other partial results, we note first, that in the case of 'success' and 'failure' the evidence for longer times for the unpleasant words is lacking for the men, though present for the women. This fact seems to be but an accentuation of a characteristic common to all the results; an examination of each set of plots shows that in every case the evidence for longer times for the unpleasant words was more pronounced for the women than for the men.[6] This holds for the preceding experiment as much as for the present one.

Secondly, we note in the last group of plots a tendency for the women to have shorter times for the pleasant words than for the indifferent words. This may have been the result of mere chance, or it may point to a real though very slight tendency for pleasant words to cause shorter times than the indifferent words. In fact a closer examination of the $\frac{P}{I}$ plots lends some support to the latter alternative, at least in the

[6] In this connection we may note that Haggerty and Kempf (*Amer. Jour. of Psychol.*, XXIV, 1913, pp. 414-425), found a greater tendency for suppression and substitution among women than among men.

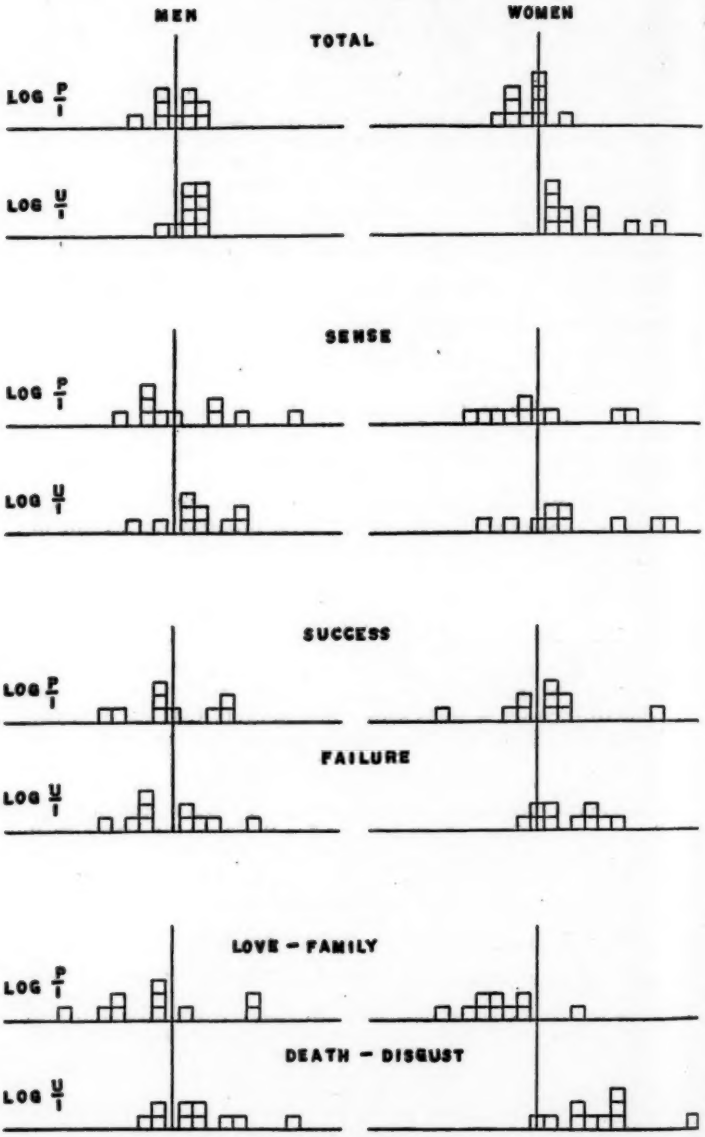
MEN
WOMEN
TOTAL
LOG P/I
LOG U/I
SENSE
LOG P/I
LOG U/I
SUCCESS
LOG P/I
FAILURE
LOG U/I
LOVE – FAMILY
LOG P/I
DEATH – DISGUST
LOG U/I

FIG. 2

case of the women. The evidence in all the cases, however, is very slight. It can be considered only as suggesting a fruitful problem for further investigation, not as indicative of an established fact.

To sum up: 1. Names of simple but unpleasant sense qualities, used as stimuli, tend to lengthen association-times quite as much as do unpleasant words of deeper emotional significance. 2. Women show the tendency to be affected by unpleasant stimulus-words more than do men. 3. There is evidence, in the case of the women, to suggest that pleasant stimulus-words may tend to cause shorter association-times than those caused by indifferent stimulus-words. The evidence for this point, however, is slight.

PROLONGED INFANCY—ITS CAUSES AND ITS SIGNIFICANCE

Some Notes on Mr. Fiske's Theory

By Max Schoen, State Normal School, Johnson City, Tennessee

In Selma Lagerlöf's book, "The Wonderful Adventures of Nils," there is recorded a conversation between a domestic goosey-gander and the leader of a flock of wild geese. The goosey-gander is desirous of becoming a member of the troop of wild geese and she is asked for her credentials:—

"There isn't much to tell about me," said the goosey-gander. "I was born in Skanor last spring. In the fall I was sold to Holger Nilsson of West Vemminghog, and there I have lived ever since." "You don't seem to have any pedigree to boast of," said the leader-goose; "what is it then, that makes you so high-minded that you wish to associate with wild geese?" "It may be because I want to show you wild geese that we tame ones may also be good for something," said the goosey-gander. "Yes, it would be well if you could show us that," said the leader-goose, "we have already observed how much you know about flying; but you are more skilled, perhaps, in other sports. Possibly you are strong in a swimming match?" "No, I can't boast that I am," said the goosey-gander. It seemed to him that the leader-goose had already made up her mind to send him home. So he didn't much care how he answered. "I never swam any farther than across a marl-ditch," he continued. "Then I presume you're a crack sprinter," said the goose. "I have never seen a tame goose run, nor have I ever done it myself," said the goosey-gander; and he made things appear much worse than they really were.

The poor showing of the domestic goose against her wild sisters gives rise to some speculation as to the effect of domestication, and its resulting characteristic, dependence, on the animal and the species. The most prominent form of this dependence is that of the period of human infancy, the meaning of which has been interpreted for us by John Fiske. It is with this interpretation, and an attempt to point out a

possible new significance of this period of animal life, that this paper proposes to deal.

I. Mr. Fiske's Theory

"It will appear that it was the lengthening of infancy which ages ago gradually converted our forefathers from brute creatures into human creatures. . . . Natural selection might have gone on forever improving the breed of the highest animal in many ways, but it could never unaided have started the process of civilization or have given to man those peculiar attributes in virtue of which it has been well said that the difference between him and the highest of apes immeasurably transcends in value the difference between an ape and a blade of grass. In order to bring about that wonderful event, the Creation of Man, natural selection had to call in the aid of other agencies, and the chief of these agencies was the gradual lengthening of babyhood."

"But this steady increase in intelligence, as our forefathers began to become human, carried with it a steady prolongation of infancy. As mental life became more complex and various, as the things to be learned kept on multiplying, less and less could be done before birth, more and more must be left to be done in the earlier years of life."

It is evident that Mr. Fiske's theory rests upon two suppositions: first, that progress was made possible by increased infancy; second, that as intelligence kept on increasing a longer period became necessary, that the animal might adapt itself to the increasingly complex mental environment. Progress is conditioned on infancy, and increased intelligence means increased complexity of environment.

II. The Meaning of Environment

Mr. Fiske's theory can be upheld provided only we are willing to grant the implied assumption that environment may mean one thing when applied to man and something else when speaking of other forms of life; while, on the other hand, it must be evident that natural environment, similar in all aspects for all of nature's creations, is the only meaning that can be taken into consideration in a purely scientific discussion of a type demanded by a subject of this nature.

There are but two instincts with which nature is concerned and which may be called natural instincts: self-preservation and reproduction. These are the only instincts that further

her sole purpose, that of maintaining and perpetuating her creations. Nature is impartial and not at all charitably inclined. She provides the organism with weapons—one as effective for its purpose as another—and lets it fight its own battles. To say that she was kinder to man than to the rest of animal life is to attribute to her a conscious purpose, which must be considered a non-scientific assumption. And in the "struggle for existence" can be included only those elements that go to maintain life, and procure food and shelter. So with environment, whether applied to man or to any other type of life, it can include natural surroundings only, that on which depends survival. We must conclude, then, that in a purely scientific discussion of the meaning of infancy as a period of adjustment to environment the esthetic, literary, and scientific inheritance and productions of the race can not be taken into account; for with these nature is not concerned. "We can not suppose," says Spencer, "that minor traits, exemplified among others by the aesthetic perceptions, can have been evolved by natural selection." (The Factors of Organic Evolution.) These must be considered as the result of man's attempt, after the dawning of intelligence, to better his conditions, and nature, "red in tooth and claw," is not concerned with bettering the condition of any animal beyond supplying it with the necessary weapons with which to maintain itself. It is beyond scientific belief that nature planned or designed anything specifically to serve man. All nature's creatures, including man, serve but themselves in so far as they carry out nature's purposes.

"She (nature) lends them every power in her possession and aids them with every tool at her command. She helps sexuality by lavishing the sexes with every kind of attraction for each other. For the other instinct she supplies the weapon for defense and quick alert wits. She lavishes such care on no other instincts, which shows their super-importance. Nature's sole purpose in all this activity is to produce, maintain, perpetuate life. She has no other purpose in view but this one. And this is as true of man as of the weed and insect. Man is held in no higher esteem by nature than is her lowest creation. One fulfills her purpose as well as the other." So if we are to determine scientifically the causes of infancy we can not include the scientific, esthetic, or literary attainments of the race. We can take into account only natural causes working through evolution and bearing upon that part of the environment only that has a direct effect on its physical preservation.

III. Man and the Struggle for Existence

Bearing in mind the elements that constitute the environment of an organism as those upon which depends its survival, let us compare the struggle for existence of man with that of lower forms of life. For subsistence the animal needs food, shelter, and safety from danger.

Food—Man obtains his food by planning for it; the animal by chance. The competition that man meets with in his search for food is of the mildest kind compared with that of the animal. He obtains his food as the reward of labor or intelligence; the animal by its wits, physical force, and at the risk of life. The animal is in constant danger of losing its life while trying to maintain it.

Shelter—Man has shelter provided for him; the animal has to seek it or make it. His shelter is also better protection from both weather and danger than that of the animal.

Danger—In both sleeping and waking hours the animal is constantly being preyed upon and in danger of its life. "The struggle for life among the birds and other wild creatures is so severe that the feeble and malformed, or the handicapped in any way, quickly drop out. Probably none of them ever die of old age. They are cut off in their prime. . . . They are always in the enemy's country; they are always on the firing-line; eternal vigilance and ceaseless activity are the price of life with them."

"Since these birds left Canada and northern New England last October they have probably traveled over two thousand miles, beset by their natural enemies at all times and places —in fields and marshes and woods; in danger of hawks and shrikes and cats by day, and of fowls and other prowlers by night; compelled to hustle for food at all times, and to expose themselves to a thousand dangers." (Burroughs, Old Friends in New Places, in Under the Apple-Trees.) Thus the animal is struggling not only for the means with which to maintain life, but for life itself. Man is subject to no such severe conditions.

IV. Intelligence, Environment, and Infancy

It is the purpose of this paper to prove that, in agreement with Mr. Fiske's theory, increased intelligence led to and resulted in a longer period of babyhood, but that, contrary to his conclusions, not the resulting complexity of the environment but its simplification as the result of the conquests of the growing intelligence brought about this result.

Man differs from all other animals in that (1) he has the greatest intelligence, (2) he is the weakest of all animals in proportion to his size, (3) he has the longest period of infancy, a period of weakness and dependence. The same distinctive characteristics exist among no animals a stage below that of man, which seems to point to the conclusion that there must exist a definite relation, a causal relation between them; that the one gave rise to the other.

As has been previously argued, with the single exception of perpetuating life the workings of nature are purposeless and without aim. When in the course of its development the animal happens to strike upon a feature that proves of advantage in its struggle for existence, that feature becomes a permanent instrument for the purpose of adaptation. Such may have been the case with intelligence. Its appearance was accidental and its consequent development due to its advantages as a means for the conquest of environment and therefore for survival. The action of intelligence upon environment made possible the modification of the environment to suit the animal, man, and not a change in the animal, in man, to suit the changing environment. Evolution, natural selection, seized upon mind, and thus physically man stopped developing. "In the whole animal world, as we have seen, every species is preserved in harmony with the slowly changing environment by modifications of its own organs or faculties, thus gradually leading to the production of new species equally adapted to the new environment as its ancestor was before the change occurred.

In the case of man, however, such bodily adaptations were unnecessary, because his greatly superior mind enabled him to meet all such difficulties in a new and different way. As soon as his specially human faculties were developed (and we have as yet no knowledge of him in any earlier condition), he would cease to be influenced by natural selection in his physical form and structure. Looked at as a mere animal he would remain almost stationary, the changes in the surrounding universe ceasing to produce in him that powerful modifying effect which they exercise over all other members of the entire organic world." (Wallace, Selection Modified by Mind, in Social Environment and Moral Progress.)

With mind as an instrument for the conquest of environment the struggle for existence was greatly simplified. "In order to protect himself from the larger and fiercer of the mammalia he made use of weapons such as stone-headed clubs, wooden spears, bows and arrows, and various kinds of traps

and snares, all of which are exceedingly effective when families or larger groups combine in their use. Against the severity of the seasons he protected himself with a clothing of skins, and with some form of shelter or well-built house, in which he could rest securely at night, free from tempestuous rain or the attacks of wild beasts. By the use of fire he was enabled to render both roots and flesh more palatable and more digestible, thus increasing the variety and abundance of his food far beyond that of any species of the lower animals. Yet further, by the simplest form of cultivation, he was able to increase the best of the fruits, the roots, the tubers, as well as the most nutritious of the seeds, such as those of rice and maize, of wheat and barley, thus securing in convenient proximity to his dwelling place abundance of food to supply all his wants and render him almost always secure against scarcity or famine or disastrous droughts." Man thus attained, by dint of mind, a position of pre-eminence above all other animals in obtaining food and shelter, safety from danger, and even to transform that which in nature is useless into things useful and fit for consumption.

We can now state our thesis as to the relation between intelligence, environment, and infancy. With intelligence acting on the environment in the manner above described, survival no longer depended on pure physical activity, alertness, and strength; and as the implements for gaining the means for survival kept multiplying and were transferred from generation to generation, the young of succeeding generations found it less and less imperative to exert as much energy as was necessary in previous ages for the accomplishment of the same end, because of the thus simplified environment; all this resulted in the loss of former physical strength, and with the progress of the ages, this inactivity kept accumulating into a lengthening period of physical weakness or infancy. "Changed conditions," says Darwin, " induce an almost indefinite amount of fluctuating variability by which the whole organization is rendered in some degree plastic." (Origin of Species.) And further, " Changes of any kind in the conditions of life, even extremely light changes, often suffice to cause variability." (Animals and Plants under Domestication.) Speaking of domesticated rabbits he says: "The want of exercise has apparently modified the proportional length of the limbs in comparison with the body. . . . In many cases there is reason to believe that the lessened use of various organs has affected the corresponding parts in the offspring. . . . Our domestic fowls, ducks, and geese have almost lost, not

only in the individual but in the race, their power of flight; for we do not see a chicken, when frightened, take flight like a young pheasant." (The Variation of Animals and Plants under Domestication.) If this is true of physiological parts there is no reason why similar disuse of once needed physical energy will not be affected in a similar manner.

V. Infancy and Survival

The earliest progenitors of the human race were pressed hardest in their struggle for survival; for, besides having to conquer an environment in its rawest and rudest state, they even lacked the most rudimentary implements for the purpose. The next generations, however, due to the experiences of their predecessors, gradually found the fight less and less strenuous and dangerous and so on through the life-history of the human race up to the present when nature yields up her richest treasures and fruits with the least physical exertion of man. As mind supersedes mere physical prowess for the conquest of nature's resources necessary for the subsistence of man, physical energy is being turned into mental power and this keeps gradually manifesting itself in a constantly lengthening period of physical helplessness. The advance of civilization, especially in its scientific aspects, manifests itself primarily by the tendency to extract out of nature the means for physical maintenance and comfort with the least expenditure of energy on the part of man. It is man's special privilege, by dint of possessing a creative intelligence, to be the ruler and master of his environment and not the slave of it, as are all the lower forms of life. In his physical development he is directly influenced in no way by his physical surroundings; for his intellect enables him to maintain life in every zone, to protect himself against his immediate environment, and even to prepare for future needs. On the other hand, the mechanical means of controlling temperature, light, and the means of obtaining food, preparing foods, and engaging in activities that require little muscular exertion, all have an indirect influence on him. Under primitive conditions of life, vigor of skin, of muscles, and digestive apparatus, were the chief factors in survival; while under modern conditions varied activity of the nervous system is the only requirement. Under modern conditions, however, survival no longer depends on an adjustment to nature's forces or changes which invariably involve physical reaction, but on the contrary, man modifies his environment so as to make nature minister to his needs

and even his comforts with the least possible expenditure of his physical energy. "The discoveries of ancient and modern navigation and the domestic history or tradition of the most enlightened nations represent the human savage naked both in mind and body, and destitute of laws, of arts, of ideas and almost of language. From this abject condition, perhaps the primitive and universal state of man, he has gradually arisen to command the animals, to fertilize the earth, to traverse the ocean and to measure the heavens."

VI. Conclusion

It is true that infancy is a period for adjustment. It is also true that the individual needs a long time for the work of learning man's vast acquirements in the arts and the sciences. But learning and dependence are not one and the same thing. Because the human infant has a wide intellectual adjustment to make is no reason why he should be unable for a longer time than any other animal to supply the means for daily living; for we must bear in mind that, as we have shown before, the intellectual part of the environment does not concern nature. In accordance with her purposes the mastery of that environment is not necessary for the maintenance of life. Furthermore, infancy can not be the result of natural selection and have caused the conversion of brutes into human beings, as Mr. Fiske would have it, because, first, nature can not be said to have purposed the creation of man, and, second, because infancy, being a period of weakness, is against her very order of things. Nature tolerates no weakness and to maintain that she is responsible for its prolongation is to maintain that she is defeating her own purpose. In nature, "Youth is a perilous time in the life of animals. The young things, with their imperfect organs, with their relics of stages that were fitted to the environment of a remote ancestor, but are out of gear with existing conditions, are hampered with the cumbrous scaffolding of the past and can offer feeble resistance to accidents and diseases. They are a ready prey for a world of hungry enemies. It is in the first place imperative that this period of feebleness should be passed through as quickly as possible." (Mitchel, The Childhood of Animals.)

AN OBJECTIVE MEASURE OF ATTRIBUTIVE CLEARNESS[1]

By EDNA E. CASSEL and K. M. DALLENBACH

Many efforts have been made and many methods have been used to discover a reliable measure of attention: a problem which Külpe long ago characterised as "one of the most important . . . . that await solution. . . . ."[2] Its attractiveness lies in the fact that it is of as great significance for practical and applied purposes as it is for theoretical and systematic psychology.

Since Geissler has reviewed the work done up to 1909,[3] we may dispense with an historical introduction, and give merely a summary of his conclusions. He found that the methods employed fall into six classes. "The first five may be classed together as methods of expression, analogous to the physiological methods employed in the investigation of the affective processes. According to these five methods the degrees of attention may express themselves in changes of (1) peripheral vision; (2) muscular strength; (3) liminal and differential sensitivity; (4) reaction-time; (5) accuracy of work. The sixth method may be likened to the method of impression. By a series of graded distractors, different degrees of attention are to be induced in the observer, and he is afterwards to report which degree he experienced."[4] From an examination of the published studies, Geissler concluded that the results are equivocal, and that for one reason or another the methods themselves are inadequate to the problem. "Although much effort has been spent upon it [the problem of measuring attention], we are still far from a satisfactory solution."[5]

Geissler, at Titchener's suggestion, adopted a new method. He proposed to measure attention in terms of attributive clearness, the single characteristic of attention upon which all writers, theoretical as well as experimental, seemed to be agreed. The attempt thus made yielded positive results, and the method itself seemed so promising that it was extended by Dallenbach to the fields of auditory and cutaneous sensation.[6] Confirmatory results were obtained in both sense departments. *Attention can be measured in terms of attributive clearness.*

Dallenbach found further, in both of his studies, that under the conditions of his experiments the reaction-time and the mean variation of this time offered reliable means for the measurement of attention. There was a positive correlation between attention introspectively estimated in terms of attributive clearness and the rate of reaction,[7] and also between attention thus estimated and the mean variation of

[1] From the Psychological Laboratory of Cornell University.

[2] Külpe, O., *Outlines of Psychology*, (1892) 1895, 429.

[3] Geissler, L. R., *Am. J. of Psy.*, XX, 1909, 473-529.

[4] *Op. cit.*, 492.

[5] *Op. cit.*, 502.

[6] Dallenbach, K. M., *Am. J. of Psy.*, XXIV, 465-507; XXVII, 1916, 443-460.

[7] *Op. cit.*, XXIV, 483-485; 501-502; XXVII, 453-455.

the reaction-time.[8] His observers, however, were not under the *Aufgabe* of reaction; they did not even know that their reactions were being timed; and he was therefore cautious in drawing his conclusions. "It is possible that a 'reaction' of this sort indexes attention, whereas a formal and set reaction, so understood by the reactor, is too complex a matter to serve as an index."[9]

In our recent work upon "The Effect of Auditory Distraction on the Sensory Reaction"[10] we took advantage of the opportunity offered to test the relation of clearness to the length of the sensory reaction. One of the observers, D, who was trained in the introspection of clearness, gave, after every series of 10 reactions, an estimation of the clearness-values of the processes involved during that period.

Three kinds of distractors were used: a metronome, beating during a series of 10 reactions; a bell, ringing just before and during the separate reactions; and a tuning-fork, sounding continuously throughout the entire period of distraction experiments. During the employment of every distraction, 100 distraction-series, and 33, 20, and 40 control series respectively, were obtained. A series consisted of 10 reactions.

The averages of the averages of the series, and the averages of the mean variations of the series, have been tabulated for every method of distraction according to the clearness of the processes involved. These data appear in Table I.

TABLE I

Average Series Reaction, Average Series Mean Variation, and Number of Series for every Degree of Clearness, under every Mode of Distraction

Distractor		Clearness					
		100–90	90–80	80–70	70–60	60–50	50–40
Metronone	Average	198.6	205.6	208.2	199.4	171.9	219.0
	Mean var.	14.8	17.9	21.0	23.0	24.0	27.2
	No. Series	41	37	7	4	1	2
Bell	Average	201.3	216.9	221.2	226.5	233.4	
	Mean var.	19.3	21.5	22.0	25.8	35.1	
	No. Series	18	37	50	14	1	
Tuning-fork	Average	218.9	220.2	231.3			
	Mean var.	17.9	19.0	21.9			
	No. Series	72	65	3			

Opposite the word "Average" appears, for every level of clearness, the general average of the averages for the separate series; opposite "Mean var." appears the general average of the mean variations for every series; and opposite "No. Series" appears the number of series used for computation.

The number of series under the distraction of the metronome totals only 90, whereas, as we have shown above, 133 series were actually taken. The discrepancy is due to the fact that clearness-estimations were not given until the observer had become accustomed to method and report of the main experiment. It was not until 40 series had

[8] *Op. cit.*, XXIV, 485; 501; XXVII, 455-456.
[9] *Op. cit.*, XXIV, 485.
[10] Cassel, E. E., and Dallenbach, K. M., *Am. J. of Psy.*, XXIX, 1918.

been taken that D included introspective evaluations of clearness in his reports.

Table I shows that the higher levels of clearness have the shortest reaction-time. There are but two cases in which a lower level gives a shorter average reaction than the next higher; and both of these should be (and were) excluded from the computation of the correlation, since they were the averages of too few series (4 and 1 respectively). In fact, all averages obtained from less than 7 series were excluded from the computation, though this procedure tended to lower the coefficients of correlation. Calculated by Pearson's familiar "product moments" method, the results are:

Distractor	*Correlation*	*P. E.*
Metronome	0.987	0.009
Bell	0.967	0.016
Tuning-fork	0.999	0.0006

The higher levels of clearness have also the smallest mean variation. In not a single instance is the average variation of the reactions of a higher level as large as that of a lower. The coefficients and probable errors of the correlations between degrees of clearness and degrees of precision (calculated as above) are:

Distractor	*Correlation*	*P. E.*
Metronome	0.961	0.005
Bell	0.913	0.012
Tuning-fork	0.984	0.002

These data show that the rate of a simple sensory reaction, and its degree of precision as expressed by the m.v., are both (under our conditions) reliable means of determining the degree of clearness. It therefore follows, since attention itself is measurable in terms of clearness, that these objective measurements also give us a reliable index of attention.

It may be urged, in objection, (1) that the observer's reports, inasmuch as they were delayed until after the completion of 10 reactions, partake more of the nature of vague impressions, of guesses, than of true introspective descriptions; and (2) that the figures, inasmuch as they are averages of averages, are artificial and not representative. To meet these objections, and further to check the method and results, the observer, during the last 5 days of the experiment,

TABLE II

Average Reaction-Time, Mean Variation, and Number of Cases for Different Levels of Clearness

Distractor		Clearness				
		95	90	85	80	75
Metronome	Average	214.08	219.87	231.45	241.37	246.00
	m.v.	16.1	18.4	20.0	24.7	.....
	No. cases	68	431	173	27	1

reported upon the clearness of his mental processes immediately after every reaction. 100 distraction-reactions and 40 control reactions were

made every day: 700 cases in all.[11] These were distributed according to the clearness of the auditory sensations from the sound-hammer. The averages, the mean variations, and the number of cases for the different levels of clearness are brought together in Table II.

The relation between level of clearness, rate of reaction, and mean variation is remarkably constant. The coefficients of correlation (as figured by Pearson's method) are:

Correlation of Clearness with		*P. E.*
Average Reaction	0.992	0.003
Mean Variation	0.972	0.013

These results corroborate those of the rougher determinations. Since they were obtained from a single observer, who was highly practised both in reaction and in introspection of clearness, we have no right to generalise them. The correlation is, however, so high and so constant, and persists through such marked shifts of attitude,[12] that we may conclude at any rate that, under these conditions of training, attributive clearness may be measured by the average duration and mean variation of the simple sensory reaction.

[11] D gave in all 1050 introspective reports of clearness. It is certain that he belongs to the dual level type; all of his reports without exception showed a clear focus and a vague background which varied reciprocally.

[12] In the study of which this is a corollary we found that D's attitude changed frequently during the course of the experiment, and also that the reaction-time varied with attitude. The present experiment shows that reaction-time is closely correlated with clearness. It would therefore appear that clearness and attitude are interrelated: as, indeed, is definitely indicated by the results of earlier experiments. We hope to return later to this general subject.

WHAT IS INTROSPECTION?

By Stephen C. Pepper, Instructor in Psychology, Wellesley College

Several influences have contributed to make a wide gap between objective method and introspection. The connotation of the terms themselves has widened the gap, one suggesting externality, the other internality. The gap has also been widened by the association of one of the terms with the natural sciences or the study of matter, of the other with psychology or the study of mind, so that the time-worn contrast of matter and mind spreads to the methods by which each is supposed to be studied. But most of all the gap has been widened by the working hypothesis of parallelism. Parallelism is only a working hypothesis. Once a year at least every psychologist delivers a lecture pointing out that fact. Yet the more the psychologist asserts that parallelism is but a working hypothesis, the more he believes in his heart that it is fundamental truth. The hypothesis has operated like a hypnotic spell to separate introspection from objective method.

The Greeks did not have that distinction. One looks in vain through Plato for what appears so clear to us. There is a distinction there between knowledge and opinion, but that is not our distinction. We sometimes meet a vulgar layman today who is slow to understand what the difference is between introspection and objective observation. We have set these blindnesses down to ignorance. But what if we be seeing double!

It is not my opinion that we are positively seeing double. There are two objects. Objective method and introspection are different, but not incomparably different. They are two extremes of a single scale. The difference between them is merely one of degree. The reason this distinction was not observed by Plato is that the natural sciences had not progressed far enough in his day to bring to maturity what we now know as objective method. The only method Plato knew was introspection. And since he knew only one method, obviously he could not observe a distinction of methods. The distinction between introspection and objective method did not become prominent until after the natural sciences had made considerable progress. In Descartes we see the beginning of the distinction. In Berkeley and Locke we see it definitive. But those were the times following the prodigious growth of physics and astronomy under Galileo, Copernicus, and Newton. In the hands of these scientists the objective method developed out of introspection. And the philosophers who followed these scientists registered and defined the distinction. The old method, therefore, is introspection. Objective method is a new discovery. To it largely we owe the astonishing advances in science during the last three centuries.

The point I wish to emphasize in this article is the absence of any qualitative difference between objective method and introspection. As a means of approaching the subject, I shall take an analysis of introspection furnished by Titchener in a series of articles which appeared

in the *American Journal of Psychology* in 1912.[1] From a criticism of this analysis and the addition of a few further remarks, the point I have in mind I think will make itself evident.

There are three parts, says Titchener, in scientific introspection,—a process, an apperception, and a description. According to the temporal arrangement of these parts,—*i. e.*, according to the way memory enters into the introspection,—three arrangements of these parts are possible. Thus there are three kinds of introspection:

1. In the first kind, "process and apperception occur together. Description is made on the basis of present immediacy.
2. In the second, "process and apperception occur together. Description is made on the basis of remembered apperception."
3. In the third, "process is recalled as memory-image. Apperception is of memory-image and description is on the basis of this apperception."[2]

Allowing p to stand for process, a for apperception, and d for description; a prime (′) over any one of these letters to stand for the recollection of the part designated by that letter; and a parenthesis to stand for a single span of consciousness; we may express the three kinds of introspection graphically as follows:

1. $(pad) - (\quad)$
2. $(pa\ ) - (a'd)$
3. $(p\ \ ) - (p'ad)$

The meaning Titchener attaches to process, apperception, and description may be gathered from the following paragraph:

"The essential thing in every case of introspection . . . . is that some conscious process or part process, some state of consciousness or complex of states of consciousness, is made the object of a 'conscious psychological apperception.' This apperception is an appraisement, a judgment, a 'placing' from the psychological standpoint, of the state or process which is to be observed. It may be explicit, consisting of a 'properly formulated sentence in internal speech,' to which may even be added an inner comment such as 'important!' or 'don't forget!' Or again it may be sketchy and fleeting and make but little claim upon consciousness,—consisting perhaps of a bare suggestion, of verbal glosses, visual ideas, and so forth. The method is completed by a description which gives the apperception or appraisement 'a linguistic expression in accordance with instructions'."[3]

For the time being we shall make no comments on the "process" p.

Let us see, however, if we are quite sure what Titchener means by "apperception" a. It is a term with a very dangerous connotation, suggesting too prominently awareness. Now, there is a pretty wide agreement among psychologists at the present day that awareness is not to be found in introspection. There has even been a disposition in a certain recent philosophical school to deny the existence of awareness altogether. But whether there be awareness or not, it is assuredly not an object of consciousness. If there be awareness, it must be a thing inferred, for nobody was ever aware of awareness.

[1] E. B. Titchener, Prolegomena to a Study of Introspection, *Am. Journ. Psych.*, XXIII., 1912, 427-448; The Schema of Introspection, *Am. Jour. Psych.*, XXIII., 1912, 485-500.

[2] The Schema of Introspection, p. 491.

[3] *op. cit.*, p. 491.

It would, therefore be impossible to remember awareness. If, then, Titchener intends "apperception" to be in any respect equivalent to awareness, it becomes immediately impossible that "apperception" should be recalled,—a fact that would strike out as invalid the second type of introspection. Also it is very difficult to see how an "apperception" could constitute a link between a process and a description if "apperception" is made equivalent to awareness and therefore is not to be thought of as an object of consciousness. On this score, all three kinds of introspection would become invalid, provided my symbolism were retained,—a symbolism which indicates a temporal sequence of the three parts of introspection.

But of course the symbolism is mine and not Titchener's, and it may not fully inclose his meaning. Indeed, I do not think it does, for Titchener's meaning seems to be ambiguous, and it is impossible to express an ambiguous statement in a single formula. In the opening sentence of the passage quoted above, Titchener speaks of a process that "is made the object of 'a conscious psychological apperception'." Obviously, if a process is the object of an "apperception," the "apperception" must be coincident with the process. At once my symbolism breaks down. But in the next sentence Titchener says that this "apperception" is "an appraisement, a judging, a 'placing'" which consists of a "properly formulated sentence in internal speech" or "of bare suggestion, of verbal glosses, visual ideas, and so forth." This meaning of "apperception" is something very different. It is description or suggested description and cannot be contemporary with the process but must be subsequent. And for this meaning of "apperception" my symbolism is perfectly correct.

Which of these meanings shall we accept? Is "apperception" to be regarded as awareness or as description? It cannot be awareness. Titchener's analysis is supposed to be an introspective analysis of introspection. But as we saw, one cannot introspect on awareness, and no one is more insistent on that point than Titchener himself.[4] It must be description, then, that Titchener means by apperception.

But now the question arises, how shall we distinguish the description that is identified with apperception from the description which Titchener puts down as the third part of the act of introspection?

The only distinction it seems possible to make is that between a partial and a complete description. In order that an introspection should be of any value to a psychologist, he must be able to compare it with other introspections. But the only way to compare introspections is to compare descriptions of them. Descriptions of introspections, however, cannot be compared unless the words used in the descriptions agree specifically in their denotations. "Cold" must mean a particular sensory experience in every psychological introspection, otherwise there is no telling what the description describes. If one subject means by "cold" what another subject means by "cool," absolutely contradictory descriptions may result. Accordingly there has developed a more or less standardized psychological vocabulary, and a description is not complete until it has been stated in terms of that standard vocabulary.[5] It is description in such terms, I take it, that

[4] E. B. Titchener, *Text-book of Psychology*, 1913, 17-18.

[5] *Cf.* E. G. Boring, Introspection in Dementia Precox, *Am. Jour. Psych.*, XXIV., 1913, 145ff., for a detailed account of the nature of a "complete description," and methods used to obtain it. *Cf.* also Titchener, Description vs. Statement of Meaning, *Am. Jour. Psych.*, XXIV., 1912, 165-182.

Titchener means by description as the third part of the introspective operation. For "a linguistic expression in accordance with instructions" would obviously be in terms of the standard psychological vocabulary if the person who gave the instructions were a psychologist. A description in terms of the standard psychological vocabulary is therefore a complete description, and any other description is only partial.

The function of the partial description is to act as a bridge between the process and the complete description when the complete description does not immediately follow the process. The subject translates a partial description which he recalls into the standard vocabulary, and the result is a complete description. Where a complete description is made directly from the process, no partial description enters in; or in other words, whenever there is a partial description, memory has been employed,—a fact which illustrates again how Titchener was confused by his "apperception." For in the first type of introspection,—viz., $(pad) - (\quad)$ —memory was not supposed to enter at all: the description was supposed to be "made on the basis of present immediacy"; yet he inserts an "apperception" in the operation. Obviously all immediacy would be dissolved by that insertion. The same confusion is seen again in the second span of the third type of introspection.

Bearing these numerous criticisms in mind, we can now reformulate Titchener's three types of introspection, and present them in the following shape (I shall let a bracketed *d* stand for partial description):

1. $(pd) - (\quad)$
2. $(p\,[d]) - ([d]\,'d)$
3. $(p\quad) - (p\,'d)$

An examination of these three types of introspection shows that the first type is the model type,—viz., (pd). What is desired is a complete description of a process. Each type begins with a process and ends with a complete description of the process. The intermediaries,—recalled processes and partial descriptions,—are incidental and are lost sight of as soon as the introspection is over; their part in the operation is simply to carry one from the process to the complete description, when the complete description does not immediately follow the process. Process and complete description are the only two essential elements in any type of introspection. Hence (pd) is the model of introspection.

Now, what is the peculiar character of (pd) which makes introspection so different from observation in the objective sciences? It certainly does not reside in the description, *d*. Every scientist must conclude his observations by a complete description of exactly the same nature as the complete introspective description, a description in terms of the standardized scientific vocabulary in which every word has a strict and specific denotation. It is the same in this respect with physicist, chemist, or biologist as with psychologist. It is not therefore the description that gives introspection its unique quality. It must, then, be the process. In other words, introspection must differ from objective observation only in the kind of data studied.

Some psychologists enlarge at great length on the absolute contrast discoverable between objective and introspective data, and write out a long list of opposed characteristics. But on the whole the list may be reduced to three. First, objective data are spatial; introspective data are not spatial. Secondly, objective data are measurable; introspective data are not measurable. Thirdly, objective data are indirectly known through the mediation of the senses; introspective data are immediately known.

This is a formidable list of opposites and a most plausible one, but it cannot stand the lightest touch of analysis. Introspective data are not spatial, it is said, yet extent is an attribute of all visual sensations. Introspective data are not measurable, it is said, yet we introspect on the relative intensities of sensations, on the relative sizes of visual sensations, etc. Introspective data alone are immediately known, it is said; other data are known through the mediation of the senses. There is a curious misconception here, as though a physicist's, a chemist's, or a biologist's sensations were not just as good as a psychologist's. What the psychologists have in mind is the objective scientist's contruction of a universe of objects and organisms with the accompanying theory that sensations are due to certain modifications occurring within the organisms. But the data for constructing this universe of objects and nervous organisms are sensations, the identical sensations which the psychologist himself has. Surely the visual sensations of a physicist are no different from the visual sensations of a psychologist, even though the physicist uses his sensations to discover the number of ether waves in a certain color, while the psychologist uses his for some other purpose. The physicist's sensation, blue, which becomes a datum of physics, is no different from the psychologist's sensation, blue, which becomes a datum of psychology.

What, then, is the difference between introspective and objective data? It is not that introspective data necessarily lack the spatial attribute, or are not measurable, or are immediate as contrasted with objective data which are mediate. All of these supposed differences are fictitious. The real difference is simply this, that objective data are picked, whereas introspective data are anything that comes along. The rare data are not the introspective data, as generally imagined; any data are introspective. Anything seen, heard, felt, enjoyed, or in any way experienced is fair game for introspection. The rare data are the objective data.

But how is this? How can data be picked? Must not a science take what it can get? These questions cannot be answered here. I must simply repeat that the sciences which employ the objective method do pick their data. And it is just this fussiness which distinguishes the objective method from the introspective.

There is a regular law that can be traced through the objective sciences governing the choice of data. Starting with the whole mass of experience, we find that the objective sciences make their first selection against the interoceptive and proprioceptive experiences. Pullings, vertigos, hungers, pleasures, pains, fancies, and imaginings are not recognized data in any objective science. In other words, kinaesthetic and organic sensations, feelings, emotions, and cognitions are all ruled out of the sphere of objective method. The remaining types of experience are acceptable in the more undeveloped objective sciences,—*i. e.*, visual, auditory, tactual, olfactory, and gustatory sensations are acceptable objective data. In a thoroughly developed objective science, however, nothing is acceptable but visual data. In short an objective method is one which limits its choice of data to experiences derived from the exteroceptive sense organs, and in refined objective method the data are further limited to experiences derived only from vision.[6]

[6] For a more extended analysis of this selective process in the objective sciences *cf.* S. C. Pepper, The Nature of Scientific Matter, *Jour. of Phil., Psych., and Sc. Meth.*, 1917, XIV., 483-491.

Think of any important experiment in such refined objective sciences as physics, chemistry, or biology, and then list the data employed in determining its results. They will be found to be mainly, if not entirely, visual. Take, for example, the experiment for Boyle's Law. This is the law that at constant temperatures the product of the volume of a gas by the pressure exerted upon it is always the same. Now turning to our stock of senses and choosing those apparently best adapted to obtain the data needed in the experiment, we should say off-hand that the temperature would be in terms of our cold and warm sensations, that pressure would be in terms of our pressure sensations, and volume in terms of our articular sensations. But what do we find? Not one of these kinds of sensations is mentioned. Temperature is in terms of visual degrees marked off on a thermometer. Pressure is in terms of certain visual degrees marked off on a U-shaped tube partly filled with mercury. Volume is in terms of certain other visual degrees marked off on the same U-shaped tube. All the data are visual. And this case is typical.

To return, now, to the distinction between the introspective and the objective methods. We found that in their abstract form they are exactly similar. Both consist of a process and a scientific description of that process. The distinction between these two methods must, therefore, be a distinction either in the kind of process or in the kind of scientific description employed. We saw that so far as scientific description is concerned no difference could be discovered. One scientific description is exactly like another. The descriptions in physics are just like those in introspective psychology. The distinction between the objective and introspective methods must, therefore, reside in the process described. And that is exactly what we find.

The introspective method will accept any kind of experiences whatsoever as fit material for its process, as fit data to be described. The objective method will accept only sensations derived from the exteroceptive sense organs, and prefers to accept only sensations derived from vision. Introspective method is democratic and recognizes no innate fitness of data. Objective method is aristocratic and insists on the natural superiority of vision. Herein lies the whole distinction between the introspective and the objective methods. They both have the form (pd). The difference between them is that in introspection $p =$ any experience whatsoever; while in objective method $p =$ sensations derived from the exteroceptive sense organs and ultimately sensations derived only from vision.

A BIBLIOGRAPHY OF *RHYTHM*

(Second Supplementary List)

By Christian A. Ruckmich

To the best of the compiler's present knowledge and endeavor, this list of 115 titles supplements and continues to date the original list of 344 titles[1] and the first supplementary list of 66 titles.[2] Since the European and especially the Germanic literature has become more inaccessible, it is impossible to vouch for the comprehensiveness or adequacy of the compilation. But with the aid of those who are interested in the subject and who in various ways have shared in the addition of titles previously omitted and of new titles worthy of recognition, the writer feels that the bibliography now fairly represents all important contributions to the general field of *rhythm*. He acknowledges indebtedness and expresses his gratitude to those who have contributed suggestions and cordially invites further criticism and aid.

As the bibliography grows in extent it is increasingly difficult to draw the line between discussions of *rhythm* proper and the various implications and applications of rhythmical phenomena in related fields of investigation. It is not at all times easy to differentiate for our purposes between studies of rhythmical phenomena made from the subjective standpoint for the sake of determining the nature of the perception of rhythm itself and studies which emphasize the objective conditions of rhythmical sequences with little or no regard for the ultimate *quale* of the rhythmical consciousness. Often the distinction is not clearly drawn in any one investigation. Many studies made in other sciences are, of course, primarily aimed at results other than those that involve mental effects. It were therefore more truthful to say that, with probable crowding at certain points, all of the titles recorded can be arranged in a linear series. At the one extreme are the investigations in which an attempt is made to discover the mental correlates of rhythmical phenomena; at the other extreme are the investigations which aim to determine the physical basis for rhythmical occurrences.

It appears further that workers in the general field of rhythm from any angle are often eager to draw material from other sources and that there is much collaboration between students in neighboring domains. For these several reasons it has seemed wisest to include in this bibliography all published studies which contribute original discussions to the general field in any of its aspects. Owing to the correlation of the various phases of the subject with one another, it will hardly be necessary to justify this policy. Consequently the bibliography refers to discussions of rhythmical phenomena in the fields of psychology, of music, of pictorial and sculptural art, of prosody, of pedagogy, of aesthetic dancing, of physiology, of biology, of geo-

[1] This Journal, 24, 1913, 508-19.
[2] This Journal, 26, 1915, 457-9.

logy, of physics, and of chemistry. Naturally the list is most nearly complete in the psychological field.

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MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY

Communicated by E. B. TITCHENER and E. G. BORING

XL. ON THE CALCULATION OF AN ASSOCIATIVE LIMEN

By H. D. WILLIAMS

Fundamentally the problem of the 'measurement of memory' is a counterpart of the problem of the measurement of sensation. In the one we seek a correlation between the 'strength' of an 'association' and the magnitude of some one of its conditions (*e.g.*, number of repetitions); in the other we wish to correlate a series of sensory impressions with a series of stimuli. In the psychophysics of sensation we may turn, in the first place, to the notion of a threshold. We can not, on the side of sensation, say how much more than adequately determined a present sensation or sense-difference is, or how much less than adequately determined an absent sensation or sense-difference is. We can state with assurance only that the sensation or sense-difference is or is not present. But if there were a stimulus just barely adequate to a given sensation or sense-difference, could determine it and call it a "threshold." As a matter of fact, however, no sense-organ remains constantly disposed for stimulation. Hence we are forced to substitute for the crude notion of the threshold that of the statistical limen, which is the stimulus-value that is just as often adequate as inadequate to the given sensation or sense-difference.[1] In like manner, in the measurement of memory we can not tell, when a given association is realized, how much more than adequate to reproduction it is, or, when it is not realized, how much it lacks of being adequate; but we can tell whether or not the association is realized. The determination of a threshold for memory appears to be the obvious 'way out;' but there are no fixed conditions that are always just adequate to reproduction, for the nervous system is ever varyingly disposed for memorial impression and reproduction, just as it is for sensory impression. Given a certain number of repetitions, let us say, then some associations are realized and others not. In such a case the proper measure seems to be the memorial limen, *i.e.*, the number of repetitions (or other measure) that produces just as many 'right associates' as not.[2]

[1] *Cf.* E. G. Boring, A Chart of the Psychometric Function, this JOURNAL, 28, 1917, 465; esp. p. 469 (note) and p. 470.

[2] The analogy between the problems of memory and those of the psychophysics of sensation is implicit in discussions of the memory-methods; *cf.* H. Ebbinghaus, *Memory*, 1913 (1885), Chap. II. Here and elsewhere the concept of the threshold is implied, although it is not explicitly formulated. A. Jost, *Zeitschr. f. Psychol.*, 14, 1897, 436ff., esp. 455-459, bases his discussion of right associates upon the notion of a *Treffergrenze*. So far as we are aware, no one, however, has attempted seriously to employ the thorough-going procedures of psychophysics to the problem of memory.

If we are to determine an associative limen we must use a method of partial mastery. Complete mastery would mean that every association was more than critically adequate to reproduction, and that we could not therefore interpolate the limen, the point of most frequent critical adequacy.[3] A 'constant method' (*Konstanzmethode*), utilizing the procedure of the method of constant stimuli, is, at the present time, the natural one to adopt. We may determine for different numbers of repetitions (say) the percentages of right associates, plot these percentages as a psychometric (mnemometric) function, and interpolate, as the limen, the point where the frequency of reproduction should be 50%. The *Treffermethode* lends itself readily to such treatment, although other methods of partial mastery, such as the methods of retained members and of prompting, can also be dealt with in this manner.

In adopting the 'constant method' we have still to decide what hypothesis of the psychometric function we shall use. Undoubtedly in an untried field an indifferent hypothesis[4] is ordinarily safest. The inexact results of memory experiments, however, make it desirable that the gross variations of the psychometric functions be smoothed off, under the principle of least squares, in accordance with some definite assumption. The *phi-gamma* hypothesis recommends itself for two reasons. In the first place, since it summarizes satisfactorily the psychophysical relationship in many cases of sensation, it is reasonable that we should tentatively attempt its extension to other psychophysical problems. In the second place, it is *a priori* the proper psychometric function, provided that the variations of nervous disposition are chance variations, and provided we are sure that our unit of measurement on the physical side is not merely a physical unit but actually a unit of *stimulus* or of some other condition of nervous impression.[5] We have adopted the *phi-gamma* hypothesis, thus *tentatively*, in this study.

Whether the 'mnemometric function' be the *phi-gamma* function or not, it seems obvious that it must have, in general, the same properties; that is to say, it must approach zero and unity gradually, and have its maximal slope at an intermediate point. From such a premise important conclusions affecting the value of the memory-methods follow. If the 'mnemometric function' is asymptotic to the 100%-line, complete mastery must be infinitely improbable. In any case, complete mastery, when seemingly achieved, is presumably due to the fewness of the cases, and its measure is exceedingly unreliable. Theoretically the weight, P, would be 0. On the other hand, half-mastery must have relatively great, perhaps maximal, reliability. Hence it follows in general (*a*) that a measure of complete mastery is less reliable than a measure of partial mastery, and that this difference works to the disadvantage of the method of complete mastery; (*b*) that percentages near 50% are probably more reliable in a method of partial mastery than percentages remote from 50%; and (*c*) that

[3] See foot-note 1.

[4] See, for example, F. M. Urban, *Psychol. Rev.*, 17, 1910, 232ff; *Arch. f. d. ges. Psychol.*, 15, 1909, 335ff.

[5] Boring, *op. cit.*, the whole discussion, but esp. p. 469. The assumption of Boring's paper is that the centimeter is a true unit of stimulus; that every centimeter disposes by an equal amount toward the impression 'two;' that 0.8 cm., for example, is twice as effective as 0.4, and 1.6 twice as effective as 0.8.

percentage-differences in one part of the percentile scale (*e.g.*, 90% to 95%) are presumably not equivalent, in a method of partial mastery, to percentage-differences in another part of the percentile scale (*e.g.*, 55% to 60%), and that the two can not therefore be compared. Measures of reliability and comparisons of percentage-differences become possible as soon as a definite hypothesis has been fixed upon, as, for example, the *phi-gamma* hypothesis.

We have laid down a theoretical programme for the investigation of memory. As a rough preliminary test, we have undertaken the determination of two associative limens, using the experimental procedure of the method of right associates and the statistical treatment of the method of constant stimuli.

We had two observers, Miss M. Kincaid (*K*) and Mrs. H. D. Williams (*W*), both with a little previous experience in memory experiments. *K* is an ingenious learner; we had, after preliminary trials, to give her additional instructions, in the effort to prevent her from making punning associations upon the nonsense syllables. She never however, acquired the ability to maintain a constant disinterested attitude toward the series.

We used throughout series of ten nonsense syllables. We had in every series five short and five long vowels (a, e, i, o, u), indicating the long vowel by a diacritical mark. In all other respects we followed Gamble's modification of Müller and Schumann's rules.[6] The order of syllables in the test series was always different from the order in the presentation and different in different tests.

We adopted number of repetitions as a measure of associative strength. Each observer learned 50 ten-syllable series. At the first session five series were presented, every one with a different number of repetitions; at the second session five more series, with the same numbers of repetitions, and so on. There were ten such sessions in all. The order in which the five different numbers of repetitions were given was changed at every session, so that every number of repetitions came equally often (twice) at every place during the session (*i.e.*, twice in first, in second, in third, in fourth, and in last place; ten times in all in the ten sessions; once in every session).

The observers were practised for two weeks before the beginning of the regular series. The ten sessions came at the same hour of the day for each observer, five sessions on five consecutive days of one week, and five sessions on five days of the next week. The work was performed in the Cornell Summer Session, 1917.

The syllables were typewritten, and presented stepwise on the Spindler and Hoyer memory-apparatus at the rate of one syllable in 0.75 sec. The test-series for reproduction was presented 15 sec. after the conclusion of the learning-series. Within a single session every series was begun 10 min. after the beginning of the preceding series. There was thus an interval between successive series of about 5 min.

The general instruction was as follows: "After the signals 'ready,' 'now,' there will be presented to you successively a series of nonsense syllables. This series will be on the revolving drum of the machine and you will see one syllable at a time. You are to fixate the left-hand portion of the window and pronounce the syllables in trochaic rhythm as they appear. Give full and equal attention to every syllable. After a number of repetitions the window will be closed at the left

[6] E. A. McC. Gamble, *Psychol. Rev. Monog.*, No. 43, 1909, 18ff.

and the first members of the pairs will be presented at the right. Then after the signal, 'now,' you are to fixate the right-hand portion of the window, and when the syllable appears pronounce as quickly as possible the syllable which followed it in the series. After you have pronounced it write it down. If you do not know the syllable which followed it, say, 'Don't know,' and put a dash on your paper."

When the experiment was completed we had presented fifty pairs of syllables for every one of five different numbers of repetitions. We scored the associates as right or half-right, and came out with even (non-fractional) percentages of right associates for every number of repetitions. The numbers of repetitions used for each observer were so determined in the preliminary experiments as to give percentages on either side of 50%. The actual numbers of repetitions used (r) and the resulting percentages of right associates (p) are as follows:

For K:	r =	1	2	3	4	5
	p =	.36	.45	.72	.69	.66
For W:	r =	2	5	8	11	14
	p =	.37	.59	.84	.83	.88

From these data we computed with the aid of Urban's tables (since we had arranged our procedure to give the even percentages which the tables require), the associative limens:

For K: h = .1534, L = 2.1029 repetitions.
For W: h = .0920, L = 3.4244 repetitions.

Considered in relation to the *phi-gamma* hypothesis, the data are manifestly unsatisfactory. Both sets show the last three percentages grouped closely together, both sets show inversions, and K's maximum occurs for the middle number of repetitions. We can tell how closely the hypothesis is approximated if we take the sums of the squares of the deviations of the theoretical percentages (the most probable values under the hypothesis) from the actual percentages,[7] Σd^2. The magnitude of this measure is dependent, however, upon the number of observation-equations; we get an independent value if we divide Σd^2 by the excess of the number of observation-equations (M, = 5 in these two experiments) over the number of normal equations (μ, = 2 for the *phi-gamma* hypothesis). If we take the square root of this quotient, we get for different cases values that are directly comparable one with another (since they are *per cents*) and that involve few digits. The resulting measure of approximation to the hypothesis we may call[8]

$$\varepsilon = \sqrt{\frac{\Sigma d^2}{M - \mu}}$$

By computation[9] we get

For K: ε = .101
For W: ε = .078

The maximal individual value that Urban found for the *phi-gamma*

[7] *Cf.* Urban, *Psychol. Rev.*, 17, 258.
[8] *Cf.* W. W. Johnson, *Theory of Errors and Methods of Least Squares*, 1915, 108f.
[9] See Boring, this JOURNAL, 28, 1917, 284, 288, 291f.

hypothesis with lifted weights is $\varepsilon = .053$; his maximal average value is $\varepsilon = .044$; his minimal average value is $\varepsilon = .031$; his minimal individual value is $\varepsilon = .012$.[10] It appears then that our results do not satisfy the *phi-gamma* hypothesis nearly so satisfactorily as do Urban's results with lifted weights.

This state of affairs does not necessarily mean that the *phi-gamma* hypothesis is incorrect. It would come about if successive repetitions became progressively less effective for association (as they do for retention). In such a case, however, the repetition could not be taken as a unit of associative strength; we should have to determine what function of the number of repetitions the effective associative condition ('associative unit') is, just as in the psychophysics of sensation we must know what function of the physical unit of our stimulating instrument the effective value of stimulus is.[11]

We can not turn to the literature for the form of this function. The method of complete mastery gives it for retention,[12] but it can not give it for learning, since this method assumes the repetition as its unit. No method of partial mastery[13] can give it, because every such method uses a *percent* of complete mastery as a unit, and equal percentile ranges can not represent equal differences of the effective condition of association on any other assumption than the very improbable one that the "mnemometric" function is a straight line.

Let us call the measure of the effective condition of association, a. then $a = f(r)$, but the f-function is unknown. We began by assuming $a = r$, and found that we did not approximate the *phi-gamma* function closely. We can not from our data determine the natures of both this f-function and of the "mnemometric" function; but we may assume either one and study the other.

Suppose now that, in addition to our original assumption, $a = r$, we assume tentatively that $a = \log r$, that $a = \sqrt{r}$, and that $a = \sqrt[3]{r}$.[14] All three functions give progressively smaller increments of a for every additional r. The square root function is less eccentric than

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[10] Computed from *Psychol. Rev.*, 17, 258.

[11] *E.g.*, in using Fechner's sound pendulum, the unit of the instrument is the degree, and the angle, Θ, is measured in degrees; but successive degrees do not represent equal increments of auditory stimulus; the unit of stimulus is $\sin^2 \frac{1}{2}\Theta$. In the same manner we may find that the effective condition of association (associative "stimulus") is some other function of the number of repetitions than a direct proportion. *Cf.* foot-note 5 above.

[12] Ebbinghaus, *op. cit.*, 52-61.

[13] W. G. Smith, *Psychol. Rev.*, 3, 1896, 21-31, gives such a function obtained by a method of retained members; E. Ephrussi, *Exper. Beiträge zur Lehre vom Gedächtnis*, 1904. 109-121, by the method of promptings; C. Knors, *Arch. f. d. ges. Psychol.*, 17, 1910, 297-361, by the *Treffermethode* and an *Aussagemethode*.

[14] It might be argued that the general logarithmic formula is not $a = \log r$, but $a = k \log r + b$, where k and b are constants. We may, however, let $k = 1$, if we do not care about the size of the associative unit in which a is measured; and we may let $b = 0$, if we do not care for what origin we measure a. Having determined our limen on these assumptions, we may alter *ex post facto* the size of the unit or the point of origin in accordance with any further consideration that may influence us.

The same argument applies to the other functions of r.

the logarithmic function, the cube root more so. We may use these values of a as abscissa-values, and compute h and the limen. We can not use Urban's tables, because our abscissa-values are no longer equidistant. We must multiply out. The limen and h come out in terms of the a-units, but the limen (not h) can be changed back into repetitions by taking the number whose logarithm it is, or by squaring it, or by cubing it, as the case may be. The results of these computations we give below. We add for W the case of $a = \sqrt[100]{r}$ to show that there is no great difference to be expected from taking higher powers.

	a	$= r$	$\log r$	$\sqrt{r}$	$\sqrt[3]{r}$	$\sqrt[100]{r}$
Limen in reps.	K	2.103	1.862	1.994	1.948	.....
	W	3.424	3.169	3.363	3.261	3.040
ε in %	K	.101	.082	.090	.087	....
	W	.078	.050	.055	.051	.054

It is obvious that the limen depends upon the hypothesis that we assume. Apparently, if $a = \sqrt[x]{r}$, then the greater the value of x the lower the value of the limen. (The limen is maximal when $x = 1$; minimal when $x = 3$ for K or 100 for W.) For $x = \log r$, we get lower values of the limen than for the cube root. We might decide which function, and hence which limen, to accept, by determining which approximates the *phi-gamma* hypothesis most closely. The values of ε show these approximations. They show that the square root satisfies the *phi-gamma* hypothesis better than the direct equation, $a = r$; the cube root is even better; improvement does not necessarily go on indefinitely, for the 100th root in the case of W is worse again; and the logarithmic function is still better than any of the root-functions tried. If we take Urban's work with lifted weights as our standard, then all the values of ε for K are too high. K was presumably too ingenious and erratic to give the steady results presupposed under the *phi-gamma* hypothesis. The values of ε for W are, however, comparable with Urban's. Two of them are less than his maximal value, .053. It appears, therefore, that, given the proper function that a is of r, together with consistent observation, we have reason to expect that the *phi-gamma* hypothesis will serve as a basis for the computation of memory-limens with a degree of reliability not very much less than the reliability with which the same hypothesis serves in the psychophysics of sensation.

We have sought to support this tentative conclusion by cases drawn from the literature of memory. For this purpose we selected the two more consistent of Knors' three adult observers, A and B; and we took for each of these observers the case where the *Treffermethode* was used with 10-syllable nonsense series. The cases are thus directly comparable with our own. In addition we took the average of Smith's results for a 10-syllable series obtained by a method of retained members, and Ephrussi's results for a 10-syllable series with Ebbinghaus as observer by the method of promptings.[15] Since the root

[15] Knors, *op. cit.*, 319; Smith, *op. cit.*, 26; Ephrussi, *op. cit.*, 111.

functions did not differ greatly with respect to ε from the logarithmic function in the preceding trials, we made these additional calculations merely for $a=r$ and $a=\log r$. The values of the limens and of ε for these new cases and for our own observers, *K* and *W*, are tabulated herewith.

	No. of observations	Limens in reps.		ε in %	
		r	$\log r$	r	$\log r$
K	5	2.103	1.862	.101	.082
W	5	3.424	3.169	.078	.050
Knors-*A*	6	1.880	1.626	.105	.089
Knors-*B*	5	1.602	1.468	.056	.005
Ephrussi-Ebbinghaus	9	2.509	2.070	.072	.084
Smith (av.)	5	3.379	2.624	.064	.022

The table substantiates our former conclusions. The logarithmic formula gives always the lower limen and, with the exception of the Ephrussi-Ebbinghaus case, the closer approximation to the *phi-gamma* hypothesis. In Smith's average case, ε is less than Urban's minimal average (.031). Knors' observer *B* approximates the *phi-gamma* hypothesis more closely than any individual case of Urban's. (Urban's minimal ε is .012.)

The two hypotheses, *viz.*, that the "mnemometric" function is the *phi-gamma* function and that effectiveness for associative impression varies with the logarithm of the number of repetitions, work so well together that one tends naturally to jump to the conclusion that each has proved the other. And if we take certain extraneous facts into account, this conclusion is not necessarily the bad logic it would seem to be. We know, on the one hand, that the *phi-gamma* hypothesis does summarize certain facts of the nervous system which hold in the sphere of sensation, and that its properties reflect the property of chance dispositional variation which we have good reasons to believe is characteristic of nervous tissue. We have indirect indications, on the other hand, although no direct proof, that successive repetitions are progressively less effective for learning. Jost's law, for example, in its simplest interpretation suggests some such fact. If we can prove neither hypothesis alone, but if there are nevertheless initial presumptions in favor of each separately, and if in conjunction the two hypotheses constitute jointly an approximate summary of observed data, then each hypothesis gains support from the other; and, at any rate, the two together may be regarded as a single hypothesis adequate to the facts, until new data are discovered which will not conform with the compound assumption.

Unfortunately for theory, we have as yet very few data that bear upon the problem. Data obtained under an inconstant attitude, like *K*'s, are scarcely admissible. If we accept such published results as there are upon their face value, then we do not always find that the logarithmic assumption, in conjunction with the *phi-gamma* hypothesis, is borne out. In general, so far as our analysis of the cases has gone, $a=\log r$ seems to give a smaller ε than $a=r$. We have seen that the Ephrussi-Ebbinghaus case is an exception; and we can find other exceptions. For example, in the 18-syllable series with Knors' observer *B*, $A=\log r$ is a better assumption than $a=r$, but $a=\sqrt{r}$ is better still. In the 18-syllable series with Knors' observer *A*, $a=r$ is an almost perfect hypothesis, much better than any other

that we tried.[16] Obviously a thorough-going study of compound hypotheses is needed. Such a study must, moreover, be made presumably upon data that are taken under more careful conditions of attitudinal control of the observer than are found in the ordinary memory experiment.

We conclude: that the problem of the 'measurement of memory,' like other psychophysical problems, can be solved most reliably and in terms that admit of the widest comparison by the determination of an associative limen; that a constant method, like the method of constant stimuli, is applicable; that such a method involves the determination of a mnemometric function, comparable with the psychometric function for sensation, and that there is reason to believe that the *phi*-function of *gamma* may prove to be as satisfactory an hypothesis in the field of memory as it has proved to be in the field of sensation; that the determination of the associative limen depends further, however, upon the use of some proper measure of the effective condition of association; that the repetition is probably not such a measure, and that the function that this measure is of the number of repetitions of a given material must constitute a second assumption of the method, at least in so far as it can not be determined independently; and finally that the two-fold assumption—that the mnemometric function is the *phi*-function of *gamma* and that the effective condition of association varies with the logarithm of the number of repetitions—appears to be in approximate accordance with the facts, although the experimental data are insufficiently reliable and show some exceptions.

We wish to emphasize the tentative nature of this study; we have sought rather to indicate a method than to make a discovery. Our work, we think, should be done over again under the most constant attitudinal conditions obtainable in an observer. It should be paralleled further by a study in which length of series is the variable in terms of which the limen is to be stated. The method could then be extended to retention. Meanwhile a thorough-going working over of the results already in the literature, with an indifferent hypothesis as well as with the *phi*-function of *gamma*, might prove valuable.

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[16] There is a simpler way of dealing with hypotheses of the value of a than the one described: it lacks, however, the advantage of giving the values of ε used above. In a given case one plots against values of r the corresponding values of γ obtained from the p for every r. Under the *phi-gamma* hypothesis, γ must be a direct measure of a. Hence, if r is a direct measure of a, we get a straight line. If the curve as plotted does not approach a straight line, we can try plotting γ against log r, $\sqrt{r}$, and so on, and select as the best hypothesis the nearest approach to a straight line. It is often easy to make a decision by inspection of the curves as actually plotted on graph paper. In a careful investigation the curves could be adjusted by the method of least squares, with every γ weighted by the corresponding P for the *phi-gamma* hypothesis.

XLI. An Analysis of the Psychometric Function for the Two-Point Limen with Respect to the Paradoxical Error

By Margaret Kincaid

We understand by the 'paradoxical error' a report of dual impression for a single-point stimulation on the skin. This 'illusion' has received attention from psychologists, and the reported experiments,[1] which have as their purpose a systematic account of the phenomenon, are evidence of its immediate impressional occurrence, apart from the effects of attentional and attitudinal variations.[2] We are proposing a mathematical analysis of the psychometric function as it is actually given by a standardized method under constant conditions; *i. e.*, we are accepting as our premise the fact of the paradoxical error and are making our problem the interpretation of this fact.

It can be seen that if the paradoxical error is strongly operative at zero separation of the aesthesiometer (a single point), the resulting psychometric function for the 'two' judgments may be hook-shaped. This fact is seen in Riecker's[3] experimental data, where the hook-curve occurs frequently. The existence of these hook-curves suggested a problem: namely, the analysis of the psychometric function into two antagonistic dispositions. Thus, in this paper, we have assumed, in the first place, a disposition *A*, which is the tendency for increase in the frequency of the judgment 'two', and which, as such, is usually thought to be the sole condition, on the side of the stimulus, of the psychometric function. We have posited, further, a disposition *B*, which represents an antagonistic tendency for the frequency of the impression 'two' to increase with smaller separations; a function that in the limiting case of zero separation might account for the paradoxical error. In brief, we have supposed that the psychometric function is a resultant of two simultaneously operative and mutually antagonistic dispositions.

Our actual experimental problem was twofold: we desired to obtain (1) data which would show an obvious tendency toward the paradoxical error, and (2) data taken under the same conditions which appeared on immediate inspection to involve no such tendency. We had, further, corresponding analytical problems: (1) to test the possibility of a mathematical resolution of the hook-curve into two hypothetical

[1] V. Henri, *Ueber die Raumwahrnehmung des Tastsinnes*, 1898, 61 ff.; V. Henri und G. Tawney, Ueber die Trugwahrnehmung zweier Punkte bei der Berührung eines Punktes der Haut, *Philos. Stud.*, 1895, 11, 394 ff.; G. A. Tawney, Ueber die Wahrnehmung zweier Punkte mittelst des Tastsinnes, mit Rücksicht auf die Frage der Uebung und die Entstehung der Vexirfehler, *Philos. Stud.*, 1896-98, 13, 163 ff.

[2] *Cf.* E. B. Titchener, *Exp. Psych.*, I., ii., 1901, 381.

[3] A. Riecker, Versuche über den Raumsinn der Kopfhaut, *Z. f. Biol.*, 1874, 10, 177 ff. There are eight hook-curves in thirty cases.

dispositions, *A* and *B*, and (2) to apply the same mathematical treatment to our 'normal' curves (*i. e.* curves without hooks), in order that the effect of analysis in the two cases might be compared.

Preliminary experiments were performed upon all available observers, in order to identify those who would be able to give the two types of data required. The observers finally selected were Miss M. Cowdrick (*C*), an advanced undergraduate student in psychology, and Dr. E. G. Boring (*B*), instructor in the department. Dr. Boring is a practised observer in cutaneous perceptions, having participated in work upon the two-point limen in two previous experiments.[4] The hook-curve which was our main objective was found for *B*'s arm, while *C*'s arm and *B*'s forehead yielded 'normal' curves.

The experimental work was carried on during the Summer Session of 1917. The stimuli were applied by a Griesbach aesthesiometer with the hard rubber points used by Boring in his nerve-section experiment. The area of stimulation was controlled by a line about 8 cm. long drawn longitudinally upon the volar side of the right arm; veins, tendons and other topographical features were as far as possible avoided.[5] A similar area was employed on the forehead: a wrinkle dividing the surface approximately in half was used as the guiding line. The points were put down longitudinally with a constant pressure of 10 gr. in varying positions on or close to these lines.

The instructions given to *O* at the beginning of each session were as follows: "After the signal 'now', you will be given a cutaneous stimulus. Make an immediate judgment of 'one' or 'two.' The judgment 'two' is to stand for two discrete impressions; all other impressions are to be judged as 'one.' Make every judgment independently, without reference to any preceding impression. Keep as constant an attitude as possible; if for any reason your attitude changes, so that you are in doubt about a particular impression, ask to have it repeated."[6] An immediate judgment was required: if the stimulus remained upon the skin for more than 3 or 4 sec. without a report from *O*, the points were removed and the stimulus was applied at a different place.

TABLE I

	P=% of '2' judgments						
D=stimuli in mm.....	2	8	14	20	26	*h*	*L*
Case I. *B*—arm.....	57	47	65	72	94	.0330	4.0316
Case II. *B*—forehead....	2	3	42	100	100	.1261	15.5114
Case III. *C*—arm.....	1	2	10	52	93	.1692	20.3833

We used the method of constant stimuli: five stimuli separated by equal steps. The size of the step was determined in preliminary experiments on *B*'s arm. For purposes of comparison the same set

[4] E. J. Gates, The Determination of the Limens of Single and Dual Impression by the Method of Constant Stimuli, this JOURNAL, 1915, 26, 152 ff.; E. G. Boring, Cutaneous Sensation after Nerve-Division, *Quart. Jour. Exp. Physiol.*, 1916, 10, 1 ff.

[5] This area was symmetrical to the pathological area on *B*'s left arm, Boring, *op. cit.*, 6 f. For the aesthesiometer, see p. 22.

[6] The same instructions were used with satisfactory results by L. B. Hoisington; this JOURNAL, 1917, 28, 588 ff.

of stimuli was used in the other cases. The separation of 2 mm. was as close to apposition of the aesthesiometer points as our instrument would permit. Five series of 100 stimulations each were used for the determination of a limen; one series as a rule was given on a single day.

The initial results appear in Table I. The obvious features are: (1) the inversion in case I; (2) the lack of inversions in cases II and III; (3) the high percentage of 'two' judgments with narrow separations in case I; (4) the close approach to 0% and 100% of 'two' judgments at either end of the series in cases II and III.

By inspection, cases II and III might be expected to approximate the Φ (γ)-hypothesis, and we may compute the h (measure of precision) and L (limen) for them. If we also compute these values for case I, we see that L is a very much smaller quantity; it is quite conceivable that, if the values of p were high enough, we might even have a negative limen as our result.

With these data, therefore, as an experimental background we are ready to begin our mathematical analysis. We must first, however, call attention to the fact that we might expect in these cases to get a close approximation to the $\Phi(\gamma)$-hypothesis for two reasons: (1) because it applies in other sense departments;[7] and (2) because such approximations are observed in many 'normal' cases.[8] If then in the nomenclature of our original analysis of the hook-curve we assume disposition A to be the Φ (γ), we are able to compute the B-function in accordance with the following logical argument. (1) We may expect the B-function to be least for our widest separations. (2) Assuming that the B-function may be neglected for the last two D's (separations), let us suppose that these frequencies determine a Φ (γ) which is the A-function. (Even if the B-function has not become negligible for the last two D's, we may still hope to get comparative results from this procedure; *i. e.* we may at least determine how much *more* the 'two' tendency of the B-function is for the first three D's although the absolute amount may be actually underestimated.) (3) The values of the B-function which we determine for the first three D's are the amount that the psychometric function departs from the Φ (γ) assumed for the last two D's. A word of

TABLE II

1	2	3	4	5	6	7	8	9	10	11
D	p	x	y	y_c (d=1.009)	p_c	Cor-y (y-y_c)	Cor-x	x_c (x+ cor-x)	$\frac{\text{Cor-}D}{6\ \text{Cor-}y}{d}$	D_c D+cor-D
2	.01	−2	−1.645	−2.992	.000	1.347	1.33	−.67	11.76	13.76
8	.02	−1	−1.452	−1.983	.003	.531	.52	−.48	4.63	12.63
14	.10	0	−.906	−.974	.168	.068	.06	.06	.59	14.59
20	.52	1	.035	.035	.520	0	0	1.00	0	20
26	.93	2	1.044	1.044	.930	0	0	2.00	0	26

[7] *Cf.* F. M. Urban, The Method of Constant Stimuli and Its Generalizations, *Psychol. Rev.*, 1910, 17, 257 ff.; Ein Beitrag zur Kenntnis der psychometrischen Funktionen im Gebiete der Schallempfindungen, *Arch. f. d. ges. Psychol.*, 1910, 18, 400 ff.

[8] *Cf., e.g.,* Boring, Urban's Tables and the Method of Constant Stimuli, this JOURNAL, 1917, 28, 280 ff.; Hoisington, *op. cit.*, 594 ff.

caution at this point may not be misplaced. It must not be thought that this 'departure' could be expressed in percentages. It is *dispositions* that we are measuring; and the application of the $\Phi(\gamma)$-hypothesis to the problem of the psychometric function is based on the assumption that disposition is measured in stimulus units (mm.), *i. e.* it is the amount of the change of stimuius that directly affects the disposition for a given judgment.[9]

An example of our actual method of computation is given in Table II. Starting with the actual γ's (col. 4) corresponding to our original p's (col. 2), we considered the last two γ's as fixed; and taking the difference between them as a unit, we spaced the other γ's at equal intervals (col. 5). We then found the necessary corrections for the γ's (col. 7) and expressed them in mm. (col. 10). These values, essential to our further procedure, will be found in col. 3, Table III. The "cor. D's" (Table II) then represent the amount that every point must be shifted in order to come on the $\Phi(\gamma)$-curve. Thus in the hook-curve the value which causes the inversion must be

TABLE III

Case		1	2	3	4		5	6
				B-function				
		k	L (mm)	Actual necessary corrections	Least square equation of corrective function $(y+b)\log x = k$		Σd^2	ε (%)
I	*B*-arm (uncorrected)	.0330	4.0316	15.49 7.94 4.78 0 0			.0344	.107
I	*B*-arm (corrected by *B*-function)	.0474	13.6960		b=4.32 k=7.84	21.73 4.36 2.52 1.78 1.29	.0527	.133
II	*B*-forehead (uncorrected)	.1261	15.5114	5.38 0 0 — —			.0501	.129 (.066)*
III	*C*-arm (uncorrected)	.1281	19.4108	11.76 4.63 .59 0 0			.1324	.210
III	*C*-arm (corrected by *B*-function)	.1692	20.3833		b=3.71 k=5.44	14.36 2.31 1.03 .47 .13	.0037	.035

* 3 observation-equations, omitting the two where the weight is zero.

[9] Boring, A Chart of the Psychometric Function, this JOURNAL, 1917, 28, 465 ff.

displaced by a large interval; *i. e.*, the tendency of the *B*-function for the judgment 'two' is greatest at small separations.

We have shown in Table III (col. 3) that all three of our cases exhibit a regularly decreasing *B*-function. Our procedure is of little value in case II, since there is only one point to show the corrective influence; two of the points have the weight zero, and two are operative in determining the Φ (γ)-curve. However, even this result conforms with the general conclusion. We had not anticipated that a *B*-function would be found in case III similar to the *B*-values in case I. The existence of such a function is an indication that the true status of affairs can not be determined by bare inspection. An analysis of Riecker's results showed that another of our expectations was equally untenable; hook-curves do not always depend upon a regularly decreasing *B*-function. Out of Riecker's eight hook-curves not one gives this type of function. Conversely, in case III above, a decreasing *B*-function may exist independently of a hook-curve. The treatment of a collection of data for the two-point limen taken in the Cornell Laboratory supports the assertion that the general form of the psychometric curve and the particular nature of the *B*-function exhibit no constant correlation.

We have endeavored further to determine whether the *B*-function can be adequately represented by any simple mathemetical hypothesis. For this purpose we employed straight lines, simple conics (hyperbolas, parabolas), and logarithmic curves. (It would of course be of no advantage to put a general conic through five known points, for it would fit exactly.) The curve which gave on the whole the most satisfactory results was $(y+b)\log x = k$. Using least-square equations, the unknowns b and k were determined and the hypothetical corrections were computed (col. 4. Tab. III). The latter may be directly compared with the actual required corrections given in col. 3.

We have assumed that the *A*-function is ideally the Φ (γ). The approximation of a given case to the Φ (γ)-hypothesis is measured by Σd^2 [10] (col. 5) or more conveniently by ε (col. 6), since ε is independent of the number of observations and is expressed in percentages.[11] Thus, if the departures of the *A*-function from the actual data are taken account of by the *B*-function, ε would be small; the use of the actual corrections (col. 3) would give $\varepsilon = 0$. As a matter of fact, the logarithmic correction (col. 4), although it was the best simple formula we could obtain, increases ε in case I and decreases it in case III (col. 6). This result means that there probably is no simple equation for case I that adequately represents the required *B*-function.

Conclusions

(1) The occurrence of the paradoxical error may indicate the existence of two antagonistic functions (here called *A* and *B*).

(2) If we assume that the *A*-function, considered as the 'normal' function, is the Φ (γ), as we may do on extraneous grounds, it is then possible by mathematical analysis to obtain the actual residual values that constitute the *B*-function.

(3) We obtained, in our three cases, a regularly decreasing *B*-function, although analysis of cases in the literature (Riecker) and of data from the Cornell Laboratory shows this result not to be universal.

[10] *Cf.* Boring, this Journal, 1917, 28, 292.

[11] *Cf.* H. D. Williams, p. 222, above.

(Riecker's values were obtained under poor conditions; some of the Cornell results are based upon too few series to be finally indicative.)

(4) Such an analytical composition of the total psychometric function can not be determined by inspection.

(5) While we do not wish to generalize beyond our few cases, we conclude that mathematical analysis does, in our cases, indicate the operation of two antagonistic factors, and that such a solution suggests a dispositional or impressional account of the paradoxical error.

(6) In view of this conclusion we suggest that the Φ (γ)-hypothesis should not be applied to the problem of the two-point limen except in the light of a preliminary analysis.[12]

[12] A strong tendency toward the paradoxical error is easily demonstrable by the application of a single point. *B*, working with knowledge, reported 'two' (and 'three' and 'four'!) impressions for the single point. We were not able to discover any qualitative difference between these multiple perceptions and those obtained with wide separations.

ERRATUM

In the first part of the Checking Table facing p. 120 above, for $p = .44$, $X = 0$, the value .8866 should be .8860. This correction has been made in the offprinted copies of the Table.

BOOK NOTES

Experiments in psychical research at Leland Stanford Junior University. By JOHN EDGAR COOVER. (Leland Stanford Junior University Publications; Psychical Research Monograph, no. 1). Stanford University, Published by the University, 1917. 665 p. (Price, $3.50 for paper, $4.00 for buckram, $5.00 for half morocco binding.)

This is the first psychical research monograph. It is evidently the view of the Stanford University, as former President Jordan says, in his foreword, that the investigation in this field should be conducted "as in other departments of knowledge." Mr. T. W. Stanford, brother of Leland Stanford, and one of the University Trustees, contributed £10,000, the interest of which is to be applied to investigations of the fields termed spiritism and psychical research. The department of psychology was asked to assume the responsibility of applying the endowment to work in this field. The department felt it must not be hasty, but reflected that these problems were closely connected with religious interests. They recalled the Seybert Commission of the University of Pennsylvania, which was under the direction of Provost Pepper, Professor Fullerton, and Dr. Weir Mitchell, that Professor Sidgwick of England had been interested; and so slowly and deliberately the psychological department decided that it could accept the "responsibility of administering the endowment," which was large enough to defray the expenses of a fellowship and to refit a laboratory room for this work. We are reminded too of the interest of Oliver Lodge in this work. We are told that Dr. Coover, the author, was made Assistant Professor.

The work is divided into five parts: Thought Transference; Subliminal Impression; Mental Habit and Inductive Probability; Experiments in Sound Assimilation; and finally, Contributions by Professor Lillien J. Martin. The experiments here described are made with due precautions and under proper conditions, and in all lines with purely negative results, as every psychologist would expect. These results are stated with great tact by the author, who discharges the delicate duty of reporting adversely to the hopes of the donor of the fund, and probably also adversely to the interests and beliefs of the founders of the University. The author is not afraid to come into close quarters with the beliefs of spiritualists and he is tactful enough not to give them ground for offence. As an argument against belief in these influences, addressed to those who are in doubt or are inclined to believe, the work could hardly be better done or reported. If, on the other hand, we regard it from the point of view of an attempted contribution to psychology, we must conclude that it has very little value. No scientific psychologist believes in either spiritism or telepathy and he will doubtless be surprised that so much tedious pains was taken, in an inquiry which could hardly have been a true inquiry even in the author's mind at the start. The psychologist will deplore the swollen proportions of this book. Let us hope that it may at least serve as an excuse for some who have been inclined towards spiritism to draw back in time.

Moral values; a study of the principles of conduct. By WALTER GOODNOW EVERETT. New York, Henry Holt, 1918. 439 p.

Professor Everett has long been one of our most effective academic teachers of ethics and it will be a gratification, not only to his own many pupils but to all teachers of the subject, that he has at length ventured to come before the public with his ripened and tried conclusions. His hope that the work may appeal to a wider than the academic circle of readers we, too, trust will be justified, for it certainly will prove an excellent guide in the solution of many of the most insistent problems of moral life. All problems of morality here are treated as those of value, and this point of view is carried through from the first chapter to the last, where it is applied to the questions of religion. All things in the moral world are grouped as better or worse, according to their contribution to the worth of human life as a whole. "In these days of the tragic conflict of warring human loyalties, when the supreme sacrifice has been unhesitatingly made by millions on both sides, it ought to become clear, even to the most ordinary intelligence, that no feeling of inner loyalty or conscientiousness can prove a sufficient principle of conduct." Morality is the business of living with all the many complex interests that business involves.

The chapter headings are as follows: The Scope and Aim of Ethics; The Locus of Moral Values; Teleological and Formal Theories; The Development of Hedonistic Theories; Historical Sketch of Some Perfection Theories; Happiness as Ultimate Value; Perfection as Ultimate Value; The World of Values; Individual and Social Values; Duty and Conscience; Virtue as the Good-Will; Moral Law; The Ethical Interpretation of Freedom; Morality and Religion.

Psychology. By BURTIS BURR BREESE. New York, Charles Scribner's Sons (1917). 482 p.

The author seeks to give a comprehensive view of the facts, theories and principles of human psychology. He tries to represent the various points of view. Starting with the nervous system he passes to attention, sensation, organic, kinaesthetic, cutaneous, and the other sensations, perception, memory, imagination, association, conception, judgment, reasoning, affection, feelings, consciousness and behavior will, and the self.

Psychology now covers so large a field that it is almost impossible to write a textbook that gives a survey of all the field without being extremely superficial and general. The author certainly has not lived up to his ideal of representing all the points of view, for he gives little recognition to behaviorism, and almost none to geneticism. He has a warm side for the physical basis of mind but has a very one-sided and limited outlook upon the field of abnormal psychology. He gives abundant stress to tests.

The secret of personality; the problem of man's personal life as viewed in the light of an hypothesis of man's religious faith. By GEORGE TRUMBULL LADD. New York, Longmans, Green and Co., 1918. 287 p.

The chief topics treated are, what it is to be a person, from the evidence of facts and of words; the centre of personality; coming to one's self; the development of personality; the person as rational, moral, a lover of beauty, religious; the goal of personal life; and finally, faith as an hypothesis. It is a book that sums up the results

of many years of thought and reflection on the part of the author, and as one follows the thought it flows so easily and naturally, without controversy, without apparently even recognizing most of the difficulties, with almost no reference to literature, every one must congratulate the author with having found a solution, apparently so satisfactory to himself, of this perhaps the greatest riddle of the universe.

Instinct in man; a contribution to the psychology of education. By JAMES DREVER. Cambridge, University Press, 1917. 281 p.

This book is based on a doctor's thesis in the University of Edinburgh. It begins with a brief historical sketch; then comes descriptive psychology, a discussion of scientific views on the nature and meaning of instinct, its physiological and psychological nature, scientific tendencies, relation to sentiments, etc. It should be made plain that the author gives no signs of having made any study of the instincts of any animal; nor does he show signs of any great familiarity with the literature upon the subject. He is rather concerned with carrying over and applying the conception of instinct to the various tendencies that he finds in the human soul. It is an interesting and rather stimulating re-arrangement of old material in new ways, but the author's contentions do not seem to be material.

An investigation of certain abilities fundamental to the study of geometry. By JOHN HARRISON MINNICK. Lancaster, Pa., New Era Printing Co., 1918. 108 p.

The author devised five sets of tests, assuming certain abilities as essential to the study of geometry, an assumption based on teaching experience. Generally the school grades bear only a very slight relation to these abilities, though this may be due to the teacher's inability to grade the pupils properly. When judged too by the scores on any of these tests, schools vary greatly in their achievements, due in part to local conditions, but in part to the teacher's efficiency, which the author thinks would be increased if these tests were used to show where the emphasis should be placed.

A laboratory outline of neurology. By C. JUDSON HERRICK and ELIZABETH C. CROSBY. Philadelphia, W. B. Saunders Co., 1918. 120 p.

This course has grown up in the University of Chicago during the last twenty years. Many teachers have participated in the work. The purpose is to assist the student to formulate his knowledge of the nervous system in terms of the functional significance of the parts. Use is made of the methods of functional analysis of the cortical nerve system which has been developed chiefly in American laboratories.

The psychology of behaviour; a practical study of human personality and conduct with special reference to methods of development. By ELIZABETH SEVERN. New York, Dodd, Mead and Co., 1917. 349 p.

This book may best be described by its chapter heads, as follows: Some New Aspects of Mind—The Psychology of the Unconscious; Intellect—The Psychology of Perception; Imagination and Memory—The Psychology of Extension and Retention; Will—The Psychology of Action; Emotion—The Psychology of Feeling; Sex—The Psychology of the Creative Life; Self—The Psychology of the Ego.

Unidextrality and mirror-reading. By JUNE E. DOWNEY and EDWIN B. PAYSON. (Reprinted from the Journal of Experimental Psychology, December, 1917, Vol. II, No. 6, p. 393-415.)

The psychological clinic of the Southern California Association of Applied Psychology. Reported by F. E. Owen. (Reprinted from the Journal of Abnormal Psychology, October, 1917, 16 p.)